SCIENTIFIC AMERICAN SUPPLEMENT. No. 1309

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Scientific American, established 1845.
Scientific American Supplement, Vol. LI, No. 1309. NEW YORK, FEBRUARY 2, 1901. Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

HER LATE MAJESTY, VICTORIA, QUEEN OF GREAT BRITAIN AND EMPRESS OF INDIA.

QUEEN VICTORIA.

IT is now 834 years since William the Conqueror crossed the Channel to found the British nation, and the reigns of the monarchs of this period are remarkable for their length. Henry III. reigned for fifty-six years and George III. for sixty years, but the reign of Queen Victoria, who came to the throne of her ancestors in 1837, was the longest in English history. Indeed, it is one of the longest reigns in the history of Europe, being sixty-three years. The official title of the late Queen was Her Most Excellent Majesty, Alexandrina Victoria, by the Grace of God of the United Kingdom of Great Britain and of the Colonies and Dependencies thereof, in Europe, Asia, Africa, America and Australasia, Queen, Defender of the Faith, Empress of India. The aged Queen and Empress lived in the hearts of her subjects, and was respected throughout the civilized world, and the prowess of the British arms made her also respected throughout the uncivilized world. It is doubtful if any woman who ever sat upon a throne more symbolized and incarnated the sovereignty. Her own personal notions of the dignity of the monarch were very high, they were, in truth, more North German than English. The English people, however, loved her none the less for that, and they also loved her the more for the glimpses which she occasionally vouchsafed them of the royal "domestic circle," which was more a home than has been the case in any other court of the period.

Though the family name of Queen Victoria was Guelph, and though the royal house to which she belonged was that of Hanover, the blood which coursed through her veins was a mixture of blood that had furnished England with sovereigns before the time of the Norman William, and down through the eight hundred and more years that have elapsed to the time of the death of George III. The eldest daughter of James I. had a daughter Sophia, who became the wife of Ernest August of Hanover, who became the mother of George I. of England. Victoria Alexandrina was born at Kensington Palace on May 24, 1819. She was the daughter of Edward Duke of Kent, himself the fourth son of George III. Her mother was the Princess Victoria Mary Louise of Saxe-Coburg-Saalfeld. Her father died the year after her birth, and owing to the absence of surviving legitimate issue of George IV. or his brothers, she became heir-presumptive to the throne on the accession of William IV. in 1830. She was educated under the charge of the Duchess of Northumberland. On June 20, 1837, her uncle, the reigning King, died. Up to this time, since the establishment of the house of Hanover on the English throne, the same monarch had worn both crowns, but with Victoria's accession they were divided, the Salic law prohibiting a female monarch from ascending the German throne, and Victoria's uncle, the Duke of Cumberland, received the Hanoverian crown, while Victoria was made Queen of England. William IV. died on June 20, 1837, at Windsor Castle. Immediately a carriage drawn by four horses and containing the Archbishop of Canterbury and the Lord Chamberlain departed for Kensington Palace. What follows has been described in the diary of Miss Wynn:

"They knocked, they rang, they thumped for a considerable time before they could arouse a porter at the gate; they were again kept waiting in the courtyard; then turned into one of the lower rooms, where they seemed to be forgotten by everybody. They rang the bell and desired that the attendant of the Princess Victoria might be sent to inform Her Royal Highness that they requested an audience on business of importance. After another delay and another ringing to inquire the cause, the attendant was summoned, who stated that the Princess was in such a sweet sleep that she could not venture to disturb her. They then said: 'We are come on business of state to the Queen, and even her sleep must give way to that.' It did, and to prove that she did not keep them waiting, in a few moments she came into the room in a loose white nightgown and shawl, her nightcap thrown off and her hair falling upon her shoulders, her feet in slippers, tears in her eyes, but perfectly collected and dignified."

About the first words the young Queen spoke when she was told the news were to request the Archbishop to pray for the widowed Queen Adelaide. When they had departed she went to her mother and informed her of the mighty change in her fortunes. Then she addressed a letter of condolence to her aunt Adelaide, asking her to remain at Windsor as long as she pleased. The letter was addressed "To Her Majesty the Queen." She was reminded that she ought to write instead, "To Her Majesty the Queen Dowager," but her answer was: "I am aware of that, but I will not be the first to remind her of her altered position." It was arranged that a Council should be held that day at Kensington.

The Queen began her public career at the meeting of this Council. She was plainly dressed in mourning, and after she had read her speech and taken and signed the oath for the security of the Church of Scotland, the Privy Councilors were sworn, and then the two royal Dukes knelt before her, swearing allegiance and kissing her hand. The charm of her manner was never better shown than in this instance. She kissed them both and rose from her chair and moved toward the Duke of Sussex, who was furthest from her and too infirm to reach her. On the following day occurred the ceremony of the Proclamation. She opened the first Parliament of her reign in November, and in the following June she was formally crowned in Westminster Abbey. The Prince of Saxe-Coburg-Gotha, Francis Albert Augustus Charles Emmanuel, was born at Coburg, August 26, 1819. In June, 1838, he visited England, and was introduced to the Queen by Leopold, King of Belgium. The acquaintance deepened into true regard, and in November the following year, 1839, Queen Victoria, who was not yet twenty-one years of age, announced formally to the Privy Council that she intended to marry the young Prince. A special act of Parliament naturalizing the young foreigner was passed January 21, 1840, and on February 10 the marriage took place.

One of the most charming and wholesome domestic pictures that royal lives have afforded is furnished in the married life of Albert and Victoria. Its influence on English domestic life in general must have been far-reaching. Prince Albert was a man of honest purposes and devoted affections; he was endowed with noble ambitions guided by intelligence. Painting, etching, and music were accomplishments that afforded amusement to both, and the Prince was a man of taste and skill in landscape gardening. He loved a country life and early hours. To these tastes the Queen learned to conform, though she had formerly preferred town life; in fact, she became eventually as fond of the country as he was.

The difficulties encountered at the outset of the union were considerable. Incident to the peculiar relations of the Queen and Prince, his position in public affairs as Prince Consort was necessarily subordinate. Great tact and a large amount of general good sense were necessary on his part to make the path a smooth one. The common judgment now is that he bore himself with conspicuous good sense and dignity in this trying situation. The Queen soon showed her determination in all matters not affairs of state that the Prince was to exercise paramount authority, and when he died suddenly on December 14, 1861, at the age of forty-two years, the English people realized that in his death they had suffered a distinct loss, and they afterward built the splendid Albert Memorial in London.

The Queen became the mother of nine children. The first was born in November, 1840. This was the Princess Royal (Victoria by name), who afterward (1858) was married to the Crown Prince of Prussia, and has since become known as the Empress Frederick of Germany. On November 9, 1841, was born Albert Edward, the Prince of Wales, who married the Princess Alexandra of Denmark in 1863. The third child was Princess Alice, born in 1843, married to Prince Louis of Hesse-Darmstadt in 1862, and who died in 1878. The fourth was Alfred, Duke of Edinburgh, born in 1844, married to the Grand Duchess Marie Alexandrovna of Russia in 1874, assumed the title of Duke of Saxe-Coburg Gotha, and died July 30, 1900; the fifth was Princess Helena, born in 1846, and married in 1866 to Prince Christian of Schleswig-Holstein; the sixth, Princess Louise, born in 1848, and married to the Marquis of Lorne in 1871; the seventh, Arthur, Duke of Connaught, born in 1850, and married to the Princess Louise of Hohenzollern in 1879; the eighth, Leopold, Duke of Albany, born in 1853, married to the Princess Hélène of Waldeck-Pyrmont in 1882, and died in 1884, and the ninth and last, Beatrice, born in 1857, married to Prince Henry of Battenberg in 1885, and widowed January 20, 1896.

Victoria's life after the death of the Prince Consort was for many years one of seclusion. For five years after his death she did not appear in public at all, and for over forty years she withdrew almost entirely from public activity, and she appeared only on such ceremonies as the opening of Parliament, the marriage of her children and grandchildren, and the laying of the cornerstones of philanthropic institutions, leaving most of the social duties to the Prince of Wales. The uneventful course of her life was varied by two great ceremonial occasions, the two jubilee celebrations of the length and prosperity of her reign. Few pageants in British history have equaled in dignity and splendor the commemoration of the fiftieth anniversary of her accession to the throne. The second jubilee, that of the sixtieth year of her reign, surpassed the first in magnificence, and the celebration was made the occasion for a demonstration of the might of the British Empire. It became known for the first time in 1897 that the Queen's health was becoming steadily worse, but there was no occasion for immediate alarm until quite recently. She died January 22, at Osborne House, on the Isle of Wight, and the entire country was plunged in the deepest gloom. Business was entirely suspended, theaters were closed, law courts suspended their functions, and the deep and sincere grief which the English people exhibited shows the great esteem and love in which the Queen was held. In all the colonies of the vast British Empire the news was received with manifestations of sorrow, and in other countries the grief and sympathy which was shown for the British people in their hour of affliction was most commendable. Nearly every court in Europe will go into mourning, and the marks of respect with which the news of the death of the Queen was received in this country shows that she had a firm hold on the hearts of all English-speaking peoples.

[Continued from SUPPLEMENT, No. 1308, page 20061.]

ARCHAEOLOGY IN THE PAST CENTURY.*

By Prof. W. M. FLINDERS PETRIE, D.C.L., LL.D. of University College, London.

SYRIA.

THE knowledge of Palestine was but slight, and of northern Syria nothing to speak of, a century ago. Travelers with some scientific ability, such as Robinson (1838 and 1852), De Saulcy (1853), and Van de Velde (1854), greatly extended our view and led up to the splendid survey by the Palestine Exploration Fund (1866 and on), which exhausted the surface study of the land. The more archæological work of excavation was begun at Jerusalem (1867-70), and resumed (1892-99) at Lachish, Jerusalem, etc. The topographical results are all important, and leave nothing to be done until excavation can be freely applied; and the small amount of digging yet done has fixed the varieties of pottery back to 2000 B. C. and given some early architecture. But the ruins of Syria, and, indeed, of Turkey in general, are practically yet untouched. The discovery (1868) of the inscription of Mesha, King of Moab (896 B. C.), opened a new prospect of research which cannot yet be entered upon. In the north of Syria nothing has been done except the German work at Singerli, from which came an Aramean inscription of about 740 B. C. And in the south a large number of early inscriptions of the Arabian dynasties, reaching back some centuries B. C., have been copied; but there, also, excavation is impossible.

The main new light from Syria has been on the Hittite power. Burckhardt in 1812 had noticed a new kind of hieroglyph at Hamath. After several ineffective copies Wright made casts of the stones in 1872. Several other such inscriptions have been found, and from these and the Egyptian and Assyrian references to the Hittites we now realize that they were a northern people, with a great capital on the Euphrates at Karkhemish, and ruling over nearly all Syria and Asia Minor. Little has yet been fixed about the writing; a few signs are read and some have passed into the Cypriote alphabet. A striking proof of the spread of Babylonian culture is seen in the tablets found in Egypt at Tell el Amarma in 1887, which show that all the correspondence between Egypt and Syria in the fifteenth century B. C. was carried on in cuneiform. These hundreds of letters give a vivid picture of life in Syria at that early date.

GREECE.

The revival of interest in Greek civilization was at first purely literary, and remained so during two or three centuries. But during the last century various travelers and residents abroad made collections which awoke an interest in the art; and though most of these collectors were content with merely showy sculpture, greatly restored and falsified for the market, yet some—such as Hamilton—took a real archæological interest in the unearthing and collecting of ancient art. The condition of study at the end of the last century was that many private men of wealth had bought large quantities of sculpture, which was but little understood and looked on more from a decorative than a scientific point of view, while there were the beginnings of a serious appreciation of it which had been just laid down by Winckelmann.

The century opened with a grand work of publishing the principal treasures of classical art in England, which was finally issued in 1809 by Payne, Knight and Townley; this marks the highest point of the dilettante collecting spirit, which was soon eclipsed by truer knowledge. Hitherto the best sculpture had hardly been known but at second hand through Roman copies; a closer acquaintance began with the travels of Dodwell, Gell, and Leake, all in the first decade of the century. The free opening of the British Museum in 1805 and the accumulation there of all the best collections within the first quarter of the century also served to educate a public taste. The first struggle of scientific and artistic knowledge against the dilettante spirit was over the Elgin marbles; by 1816 they were accepted as the masterpieces which all later criticism has proved them to be. The Aeginetan and Phigaleian sculptures, brought to Munich and London, helped also to show the nobility of early Greek art; so that the last two generations have had a canon of taste to rely upon, the value of which cannot be overestimated.

Following on this noble foundation other collectors worked in Greece and Asia Minor, and the British Museum profited by the labors of Burgon, Fellows, and Woodhouse between 1840 and 1860. The diplomatically supported work of Newton on the Mausoleum (1857-58), and Wood at Ephesus (1863-75), filled out our knowledge of the middle period of Greek art (350 B. C.). Comparatively little has been done since then by England, but the activity of the Germans at Olympia has given us the only original masterpiece that is known—the Hermes of Praxiteles (350 B. C.), and their work at Pergamon revealed the great altar belonging to the later age (180 B. C.). The excavations at Athens (in 1886) have produced the impressive statues dedicated to Athene about 520 B. C., which reveal the noble rise of Attic sculpture. But attention during the last quarter century has been largely fixed upon the earlier ages. The discoveries of Schliemann at Hissarlik (Troy, 1870-82), Mykenæ (1876), Orchomenos (1880-81), and Tiryns (1884), opened a new world of thought and research. Though at first bitterly attacked, it is now agreed that these discoveries show us the civilization of Greece between 2000 and 1000 B. C. Lastly, during ten years past Egypt has provided the solid chronology for prehistoric Greece, by discoveries of trade between the two countries.

We can now very briefly estimate the present position of our knowledge as gained during this century. Setting aside the early foreign pottery found in Egypt which belongs probably to Greece or Italy at 5000 and 3000 B. C., we first touch a civilized city in the lowest town of Troy, where metal was scarcely yet in use, which is certainly before 2000, and probably about 3000 B. C. in date. Succeeding that is the finely built second Troy, rich in gold vases and ornaments, which—though mistaken by Schliemann for the Homeric Troy—must yet be long before that, probably before 2000 B. C. After the burning of that come three other rebuildings before we reach the town of the age of Mykenæ, about 1500 B. C. Of this, which was in Greece the climax of the prehistoric civilization, there are the splendid treasures found at Mykenæ, the magnificent domed tombs, the abundance of fine jewelry and metal work, of beautiful pottery and glazed ornament. To this age belong the great palaces of Mykenæ, Tiryns, Athens, and other hill fortresses, of which hardly more than the plans can now be traced. And it is this civilization which traded eagerly with Egypt, exchanging the valued manufactures of each country. This period was at its full bloom from 1500-1200 B. C., and began to decay by 1100 B. C., this dating being given by the contact with Egypt.

This natural decadence of art in Greece was hastened by the invasion of the barbarous Dorians about 1000 B. C. Art, however, was by no means extinguished, but only repressed by the troubles of the age; and Athens which was not conquered by the Dorians was the main center of the revival of the arts. Other examples of such a history are familiar in Egypt (after the Hyksos invasion) and in Italy (after the Lombards), where earlier abilities revive and bloom afresh when vigorous invaders become united to an

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artistic stock. After the centuries of warfare a quieter age allowed the growth of fine arts again in the seventh century B. C., largely influenced by Egyptian and Assyrian work at second hand, through the Greek settlements in Cyprus and Egypt. By 600 B. C. definite types of sculpture were started, and a course was begun which only ended in the fall of classical civilization. The century before the Persian invasion in 480 B. C. was one of rapid development; and in sculpture and vase-painting we see that this century carried forward the arts to technical perfection and the highest power of expression. Immediately after the Persian wars came the supreme works of Pheidias and Myron, most familiar in the Parthenon and the Discobolus; and in vase-painting comes the reversal from vases drawn in black on a red ground to the blocking out of the ground in black leaving the figure in red, thus giving far greater scope to the filling in of finely drawn detail. The civilization of Athens was also at its height in this age, under Pericles, and the minor arts received their most refined and perfect treatment. After this comes nothing but ripening to decay. It must always be remembered that we have but very few examples of original work of the great artists. Nearly all the actual marbles preserved are copies made in later times, which show little of the delicacy of the original; and the few original marbles that remain are mostly of unknown subjects by unknown men. The great work in Greek archæology during the last fifty years has been comparing the records of ancient art (in Pliny, Pausanias, etc.) with the remaining sculptures, critically assigning the various types of statues to their celebrated originals, and thus forming some idea of the real history of Greek art. From these studies, full of detail and controversy, we may briefly sum up the characteristics of the principal artists and their imitators. At about 440 B. C. Pheidias showed in the Parthenon the highest expression of divine and mythic forms, in a simple and heroic style which was never equaled. Half a century later Polykleitos followed a more human expression, using motives (as in the Doryphoros), but yet portraying an abstract humanity. By 330 B. C. Praxiteles brought the expression of moods to his works, graceful, animated and with a full ripeness as in the Hermes of Olympia, or the Faun. Skopas, slightly later, marked his work by his great vigor and strong personality. This was the second turning point, when ripeness passed into decay; and in Lysippos there is mere vivid naturalism and an impressionist manner without much soul or thought, as in his Apoxyomenos, about 330 B. C. After this mere triviality and genre subjects are usual, portraiture is a common aim, and dignity was vainly striven for in colossal size. The glorification of showing dead and vanquished enemies is seen in the Dying Gaul and figures of slain foes at Pergamon. Later on, about 180 B. C., we see the violent, complicated, and straining action of the figures around the great altar of Pergamon, which also appears in the groups of the Laocoön and Farnese Bull. In the Græco Roman age a conscious artificiality took the place of life and expression, as we see in the Apollo Belvedere, the Venus di Medici, and the Farnese Hercules. Art was saved in the first century A. D. by the devotion of portraiture, which gave a sense of reality and conviction which is entirely absent in the imaginative works. Lastly, a painstaking study and admiration of earlier works led under the wealthy patronage of Hadrian (130 A. D.) to an eclectic revival which was wholly artificial and passed away within a generation. We have fixed on sculpture as the most complete expression of Greek art; in other directions there is neither enough material nor enough research to give us a connected view. Not a single town, hardly a single house, in Greece has been excavated; there is no consecutive knowledge of the ordinary products and objects of life, and there is very little recorded of the discoveries of the tombs. The artistic interest of the sculpture and architecture has starved other branches of archæology, and for Greece more remains to be done than for some less celebrated lands.

ITALY.

The interest in Italy at the beginning of this century was mainly for the sake of its second-hand version of Greek art and for the architecture and painting of the Renaissance. On the contrary, now the objects from Greece itself have far eclipsed the Italian copies, and the interest lies in the early Italian civilization and its purely Roman derivatives; while modern taste values the mediæval art of Italy far from the bastard products of the florid age which followed. The first detailed studies in Italy were those on Pompeii, especially by Gell (1817), which made that debased style very popular and paved the way for appreciation of better work. The various isolated discoveries of Etruscan tombs were summed up in the admirable work of Dennis (1848), which presented a general view of that civilization which has not been superseded. The earlier Italic culture has been examined in many places where accidental discoveries have revealed it during the latter half of the century, and especially in the systematic work of Zannoni at Bologna (1870-75), and of Orsi lately, in Sicily. The history of the city of Rome has been almost rewritten in the last thirty years owing to the great changes of the new government; these have been largely worked by Lanciani, and recorded by him and Middleton. The view of Italian history at present begins in the Stone Age, which has been well studied, and has links with the later periods, as in the general use of black pottery. The earliest metal objects are very simple blades of daggers, found in graves mingled with flint arrow heads and knives. The admirable Italian plan of preserving whole burials undisturbed in museums enables us to see these graves complete in the Kircherian Museum. A special branch of the early Bronze Age life was the system of lake dwellings (natural or artificially water girt), which abound in the northern Italian lakes and over the plain of Lombardy. These towns ("terra mare") are arranged on a rectangular plan, and form the earliest stage of many of the present cities. The full development of the Bronze Age civilization seems to have been later than in Greece, at about 800 B. C., to which belong the great discoveries of tombs, weapons, and tools at Bologna, and the cemetery at Falerii.

Upon all the native Italic civilization came an entirely different influence from the immigrant Etruscan. Traditionally coming from Asia Minor, he brought art and religion which had no relation to the Italic. The earliest Etruscan paintings are strongly northern in style, influenced by north European feeling (Veii). But soon the Etruscan borrowed largely from other races, from the Greek mainly, but also from Assyria and Egypt. Thus the fascinating problem in Italy is to distinguish the various sources of Italic, Etruscan, Græco-Etruscan, Oriental-Etruscan and pure Greek which are found in all degrees of combination before Roman times, and which can still be traced through the Roman age. The characteristics of Etruscan taste are: (1) The extraneous objects and figures, such as rows of pendants to a metal vase, monstrous heads standing out from a bowl, and statuettes placed for handles; (2) in forms of vases and furniture, the combination of many different parts and curves which never form a whole design; (3) and in sculpture the large round head and staring eyes. In general, an air of clumsy adaptation by a race deficient in originality. The glory of the Etruscan was his engineering, which he handed as a legacy to Rome. Strange to say, although thousands of Etruscan inscriptions are known, and many words are translated, yet the language is sealed to us, and none of the many attempts to read it has succeeded. The scientific study of Etruscan tombs has been well followed lately, as shown in the Florence museum, where a separate room is devoted to each city.

In the south of Italy Greek art prevailed, and many of the finest works belong to this civilization. The Greek in Italy had rather different ideals to those of Greece; he started more from the level of Polykleitos and Praxiteles than from the severe age; his favorite type is that of youth and adolescence, never of maturity. The grace and feeling of such bronze statues as the Hermes and so-called Sappho of Herculaneum are peculiar to southern Italy. And when the Greek artist penetrated north and allied himself with the mechanical skill of the Etruscan, such splendid work was done as the Orator of Sanguineto.

Rome in the earlier centuries was an Italic town which came under Etruscan influence as Tuscany was conquered. But from the age of foreign conquest in the first century B. C. Greek art in a debased form ruled over all else, and ran into utter degradation in the third century A. D. It was this art that the power of Rome spread around the whole Mediterranean from Palmyra to Britain, and is the parent of most modern decoration. But in the great reconstruction of the Empire under Diocletian the debased Greek taste was mostly shaken off, and Rome went back to the old Italic-Etruscan style and motives. The statues have the round heads and staring eyes of old Etruria; the taste for quaint accessories, such as lions supporting objects, came back and passed into mediæval art, and the exaggerated lengthy forms of men and animals reappeared.

Of the Christian period De Rossi's work in the catacombs has given a firm base of facts for the third to the sixth century A. D., the actual tomb and body of St. Cæcilia being the most striking result. The later Roman and mediæval age in Italy is full of interest, but in that—as in the rest of mediæval Europe—research has been mainly on architecture and objects which are not the result of excavation, and space prevents our noticing it.

INDIA.

The Hindus have never been chronologists or historians, and their great Sanskrit literature tells practically nothing about the rise of Buddhism, the invasion of Alexander, or the spread of civilization in Indo-China. All before the Islamic conquest in the tenth century A. D. is in a mist of Turanic mythology. Here, then, more than in other countries, archæology has restored the history, and done so entirely within this century.

AMERICA.

Archæological work in the United States and in Central America was begun by Squier about the middle of the century, and the attention thus drawn to the subject has borne fruit in the more accurate and scientific explorations connected with the surveying and geological departments, and, above all, those of the Smithsonian Bureau of Ethnology. The names of Whitney, Wright, Cyrus Thomas, Holmes, Fowke, Mindeleff, and others will be familiar to all American readers by their work of the last twenty years, and need no introducing here.

The earliest remains of man in America—or perhaps in the world—are those beneath the great lava beds of California; since those were deposited the rivers have cut their beds through 2,000 to 4,000 feet of lava rock, implying an erosion during tens, or perhaps hundreds, of thousands of years. But little can be assigned, however, with any certainty to a date before the Christian era, though mounds of refuse on both ocean shores may probably belong to an age before any human history.

The most important studies have been those on the highest civilization of the continent, that of Central America. The destroying Spaniards preserved but little of native record, except incidentally, and the first collector of Aztec MSS. was Benaduci (1736), of whose treasures but an eighth survived his imprisonments and persecutions, one of the greatest disasters to history. The first great publication of manuscripts was the magnificent work of Lord Kingsborough (1830); and almost at the same time appeared Prescott's history. Though the later researches have shown that the land was divided into many small kingdoms, rather than under one power, as Prescott supposed, yet his account of the calendar and chronology of the Aztecs has been verified and added to, and far more has been done in reading the MSS. than he supposed possible. Aubin after years of work in Mexico brought to Europe MSS. of an entirely new kind, showing a fully developed system of phonetic writing, which he has largely deciphered with success, having analyzed over one hundred syllabic values correctly.

One of the most complete studies has been that of the Mayan Quiché peoples, and especially of the Mayans of Yucatan. In 1864 Landa's work on Yucatan (written 1566) was rediscovered, and the account of the calendar has sufficed to enable Goodman to discover the meaning of a very large number of signs (1897); these enable the numerical documents to be translated, and show that a period of as much as 8,000 years was dealt with by the Mayans, perhaps belonging to mythical ages. The alphabetic signs of Landa have proved useless so far, and Goodman even disbelieves in any record except that of numbers. Seler has shown the identical origin of the signs used by Aztecs and Mayans for the days and months. Little had been done to make known these remains until the recent explorations, casts and publications, of Maudsley, who has worked magnificently for seventeen years at Copan, Palenque, and Chichen-Itza; these, however, are but three of innumerable cities of Guatemala and Yucatan that need exploration.

In New Mexico the many ruins from the Colorado to the Rio Grande have been proved to resemble those of the modern Pueblo Indians, and to have none of the characteristics of Central American architecture; there are no sculptures, and the rock inscriptions are too primitive to be interpreted. Nothing points to an Aztec occupation, and probably the ancestors of the present people were the builders.

The innumerable earthworks of the Mississippi Valley were formerly supposed to belong to some vanished race. And the view that they were connected with the Central American civilization is favored by the pyramid mound, which was hardly known otherwise, and by the excellence of the minor sculpture. But there are great differences between the two civilizations. The mound builders were far inferior in metal working, and their burial customs are peculiar. The use of materials from both east and west coasts shows an extensive commerce. The best summing up of the researches is that by Prof. Cyrus Thomas, after his extensive excavations. He concludes that the remains of the mound builders show no great antiquity; that they were formed by tribes like the existing Indians; that the builders were of the same culture as were the Indians when discovered; that such mounds continued to be made and used for burial during the European period, and that the principal builders were the Cherokees. (India and America are here treated with the assistance of Mr. J. S. Cotton and Mr. D. MacIver.)

It will be seen now how totally our view of man's history has been changed by the study of archæology, and how fundamentally this science affects our ideas of the past and our expectations for the future of our race. The main outlines have been dimly seen; but in every country the greater part yet remains to be done, and in Turkey, Persia, and China most important civilizations are as yet quite untouched by exploration. The coming century will no doubt see a harvest from these lands; and it is to be hoped that what yet remains in the safe keeping of the earth may be found by able men, who will preserve it for instruction, and enable posterity to trace the fortunes of our species.

THE PASSIVE STATE OF METALS.

THE veteran scientist Hittorf, of Muenster, Westphalia, has for some years been occupied in the study of the peculiar features which the so-called active and passive states of certain metals, notably iron and chromium, offer; and, as a result, he laid a new communication on this problem before the summer meeting of the German Electro Chemical Society in Zurich. But we cannot say that he has quite probed the problem to its root, says Engineering. If iron is dipped into concentrated nitric acid it turns passive and behaves like platinum, which nitric acid cannot attack. If the acid is diluted below the density 1.3 the iron is at once dissolved. On the authority of Schoenbein and of Faraday this passivity has been ascribed to the formation of a film of oxide on the surface of the metal, which oxide is not soluble in strong nitric acid. No positive proof for the existence of this oxide film has ever been given, and Hittorf, who has not been able to discover any traces of it, is convinced that it does not exist. Ordinary iron and chromium, cleaned with emery, if necessary, are in the active state, and are attacked by many acids and salts. But if they are made the anode, in a galvanic couple, containing certain of their own salts, as electrolyte and a platinum cathode, then, without applying any external current, the electro-motive force, which in the case of the active chromium is 1.8 volt, at once goes down to almost nothing and the metal proves to be in the passive state. The passive state slowly disappears again, and as the oxides to which the passivity might be due are insoluble in the respective salt solutions, Hittorf concludes that there is no such film. If an external current is applied to a chromium anode the metal dissolves as acid, or in its highest state of oxidation. Iron does not, as a rule, form ferric acid under these circumstances; but it does in concentrated solutions or fusions of caustic alkalies, a subject to which F. Haber referred more fully at the same meeting; oxygen is generated at the iron anode. The slow return from the passive to the active state can be hastened by making the metal a cathode; but the introduction of free hydrogen is useless. Nickel and cobalt behave similarly to a much smaller degree; however, the phenomena can only be observed when special precautions are taken. When iron is tinted by heating it under access of air it is covered with a fine film of oxide, which is not soluble in concentrated nitric acid, but soluble in diluted nitric acid. This is Schoenbein's experiment. But this iron (or chromium) is, according to Hittorf, not in the passive state, as had been assumed, for in a galvanic cell it gives almost the same high electromotive force as a fresh, inappreciable oxide film. Yet one cannot help feeling that we have in these phenomena to deal with polarization effects. It need not come to a real oxidation; a condensed film of gas on the metallic surface, an approach of oxygen, as Principal O. Lodge put it in his address on "The Volta Contact Force," would suffice to explain its peculiarities; and we rather wonder that attention has not been drawn to this possible explanation.

[Concluded from SUPPLEMENT, No. 1308, page 20963.]

METEOROLOGICAL INSTRUMENTS.

By Prof. HANS HARTL.

THE reduction to sea-level can also be made with fair accuracy by means of the reduction disk shown in Fig. 10. The instrument is provided with a pointer which is rotated until it is opposite the number on the right hand scale of the disk, corresponding with the observed barometric pressure. The left hand end of the pointer will then indicate the pressure at the level of the sea. Each station must have a specially-constructed disk, the records of which are accurate only for a certain temperature.

FIG. 8.—A LAMBRECHT ANEROID BAROMETER.

Even as there are liquid and metallic thermometers, so there are also liquid and metallic barometers. These liquidless or "aneroid" barometers, as they are called, although not as accurate as mercurial barometers, are nevertheless very compact and strong. Figs. 8 and 9 represent an aneroid barometer. The instrument consists essentialy of a vacuum-box, *D* (Fig. 9), provided with a resilient sheet-metal cover which is pressed inwardly by the atmosphere. When the at-

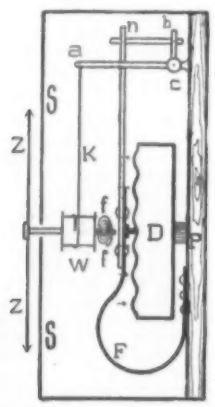

FIG. 9.—DIAGRAM OF AN ANEROID BAROMETER.

mospheric pressure increases the cover is forced inwardly to a greater degree; when the atmospheric pressure decreases, the cover, by reason of its resiliency, springs back. The center of the cover, therefore, constantly moves back and forth. If this movement could be recorded, it would be possible to ascertain the state of the atmosphere. For this purpose a stud is secured at one end to the sheet-metal and at the other end to a lever, screwed to the spring, *f*.

FIG. 10.—REDUCTION DISK.

The end, *n*, of the lever, through the medium of the link, *nb*, controls the arm, *cb*, of the bell-crank lever, *acb*, from the end, *a*, of which a fine chain, *K*, extends downwardly and passes about a drum, *W*. The shaft of the drum carries an index, *Z*, which indicates the atmospheric pressure on a scale, *S*. (In Fig. 8 the index and scale is seen from the front.

As the pressure of the atmosphere increases, the cover of the vacuum-box is forced in further. This movement is multiplied or increased by the lever and communicated by the link, *nb*, to the bell-crank lever which pulls the chain, *K*, thereby turning the drum, *W*, together with its shaft and the index-finger. Simultaneously the spring, *f*, is subjected to greater tension. When the atmospheric pressure decreases, the parts all move in the opposite direction. It might, therefore, occur that the chain, *K*, would hang down loosely; but the spiral spring, *f*, turns the shaft sufficiently to take up the slack of the chain.

In connection with the Lambrecht aneroid barometer (Fig. 8) two index-fingers and scales are used. The finger drawn in full lines indicates the air-pressure in terms of the height of a mercury column (millimeters); the other finger shows approximately the barometric pressure at the level of the sea. In our illustration the actual barometric pressure is 730 millimeters; the pressure reduced to the level of the sea, 764 millimeters.

In aneroid barometers a correction need not be made for temperature. It is, however, evident that the expansion and contraction of the various parts are not without their effect on the recorded pressure.

Self-recording barometers or barographs, as they are called, operate in a manner similar to that of self-recording thermometers. The barograph, as shown in Fig. 11, consists of superposed vacuum-boxes 1, 2, 3,

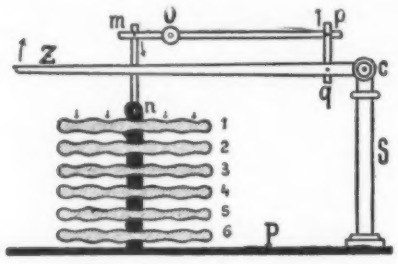

FIG. 11.—DIAGRAM OF BAROGRAPH.

4, 5, 6. The boxes are connected by metallic cylinders or ties soldered in position and firmly mounted on the base of the apparatus. If the atmospheric pressure increase, the resilient sheet-metal covers of all the boxes are forced inwardly, and the boxes themselves move downwardly. The total downward movement is expressed in the uppermost box. If the atmospheric pressure decrease, the resilient covers move correspondingly and the boxes move upwardly. The movement of the boxes caused by the changing condition of the atmosphere is transmitted through the member, *n*, and a connecting-link to the lever, *mp*, fulcrumed at *O*, and is multiplied at the end, *p*, of the lever. The movement of the point, *p*, is communicated by the link, *pq*, to the index-finger, *Z*, pivoted at *C*. The point of the index-finger (Fig. 12) carries a pen filled with ink, by means of which the constantly-changing pressure of the atmosphere is recorded on ruled paper wound round a rotating drum.

It has been remarked that the atmosphere contains a certain quantity of invisible watery vapor. Air has the property of absorbing a volume of water which varies with the atmospheric temperature. Thus, for example, one cubic meter of air at a temperature of + 18 degrees C. absorbs 15.4 grammes of water in the form of vapor, and at a temperature of + 10 degrees C. only 9.2 grammes. The quantity of moisture which can be absorbed is limited. When the air of a room is saturated with moisture and can absorb no more, the surplus vapor collects on the window-panes in the form of drops. The greatest quantity of water which can be absorbed by one cubic centimeter of air at a given temperature is called the maximum moisture corresponding with that temperature.

The maximum moisture for given temperatures can be ascertained by reference to specially prepared tables or to the thermometer of the Lambrecht polymeter (Figs. 13 and 16). This thermometer is provided with two scales—a temperature scale to the left, and a moisture scale to the right, on which the maximum moisture corresponding with every degree of temperature is indicated.

In the preceding example it was stated that each cubic meter of air at a temperature of + 18 degrees C. absorbed 15.4 grammes of watery vapor. But if the air of a room contain but 10.8 grammes of water per cubic meter, the actual or absolute moisture is said to

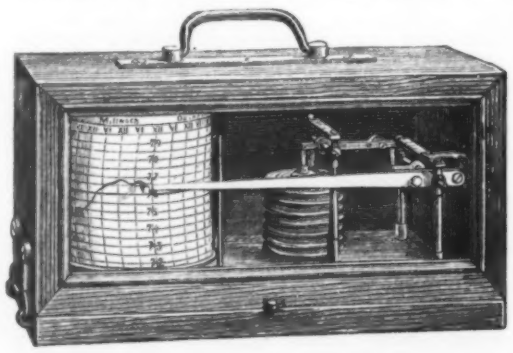

FIG. 12.—THE BAROGRAPH.

be 10.8 grammes. If the relation of the absolute moisture (10.8 grammes) to the maximum moisture (15.4 grammes) be expressed in per cent, then the relative moisture, as it is called, is thus obtained. In the present case the relative moisture = 100 × 10.8 ÷ 15.4 = 70 per cent. The relative moisture is found by multiplying the absolute temperature by 100 and dividing the product by the maximum moisture.

If air at a temperature of + 20 degrees C. has an absolute moisture of 10.5 grammes, it must be cooled to + 12 degrees C. before it can be saturated with watery vapor. But if the cooling process be carried still further, to + 11 degrees C. for example, the air will retain but 9.8 grammes of water per cubic meter, so that 0.7 gramme is eliminated. The moisture thus subtracted collects on cold objects (window-panes and the like) in the form of dew. This deposition of dew, in the present instance, begins as soon as the temperature sinks below + 12 degrees C. Hence, the critical temperature is called the "dew-point." If the absolute

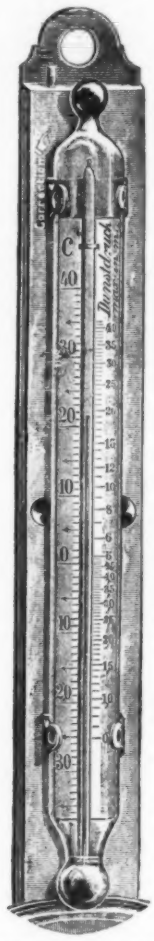

FIG. 13.—LAMBRECHT POLYMETER.

moisture be known, the dew-point can be found by reference to tables or to the polymeter.

Dew-points can also be immediately ascertained by means of special instruments, as a type of which the Lambrecht dew-point mirror may be cited (Figs. 14 and 15).

In a casing closed at the front by a highly-polished metallic mirror the bulb of a mercury thermometer is placed, the tube of the thermometer being so bent that the mercury and the scale are reflected in the metallic mirror. The temperature, therefore, is read from the reflected image of the thermometer scale. In the metallic casing is a fan which is rapidly rotated by a blast of air from a small bellows. Ether poured into the casing through a small funnel will rapidly evaporate when the fan is set in motion. This rapid evaporation produces cold, which affects the thermometer, mirror, and the air. When the dew-point of this air is reached, a film of moisture will make its appearance in the center of the mirror—the coldest point. As soon as the moisture begins to collect, the temperature is read; and thus the dew-point is ascertained.

When the dew-point has been determined the relative moisture of the air can be easily calculated. Let it be assumed that the thermometer indicates a temperature of + 18 degrees C., that by means of the

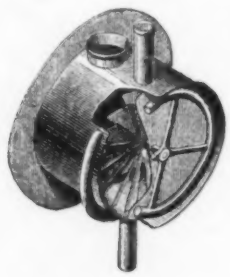

FIG. 14.

mirror the dew-point is found to be + 11 degrees C. Then the absolute moisture is 9.8 (maximum moisture for + 11 degrees C.); while the maximum moisture for + 18 degrees C. is 15.4. Hence the relative moisture is 100 × 9.8 ÷ 15.4 = 64 per cent. Conversely, the dew-point can be calculated if the temperature and relative moisture of the air be known. If, for example, the temperature be + 16 degrees C., the relative moisture

64 per cent, then we know that the actual (absolute) moisture is only 0.64 of the maximum moisture. By referring to a table the maximum moisture for + 16 degrees C. is found to be 13.5. Hence the absolute moisture = 13.5 × 0.64 = 8.6. But 8.6 is the maximum moisture for + 9 degrees C. Consequently the dew-point is + 9 degrees C.

It is evident from the preceding example that the dew-point can be found without the aid of a special instrument if the relative moisture of the air can be measured. By means of the hygrometer the relative moisture is easily determined.

The hygrometer used in connection with the Lam-

FIG. 15.—LAMBRECHT DEW-POINT MIRROR.

brecht polymeter is shown in Figs. 16 and 17, respectively exterior and interior views. In the instrument a strand, *H*, of human hair (preferably that of a woman) deprived of all fat, is secured at its upper end at *f*, and at its lower end to a crank, *k*, carried by the shorter and heavier arm, *g*, of an angle-lever pivoted at *O*. The longer and lighter arm of the lever serves as a pointer and terminates in a trident, *Z*. Hair has the property of expanding or lengthening with an increase of relative moisture and of contracting with a decrease in relative moisture. Since the strand of hair is constantly under the tension imposed by the weight of the arm, *g*, it is evident that an increase or decrease of relative moisture and a corresponding expansion or contraction of the hair will be accompanied by a movement of the pointer, *Z*, which plays over a double scale. The central point of the arm, *Z*, indicates on the lower scale (graduated from 0 to 100) the relative moisture. Hygrometers which are employed at no great elevations are influenced by the moisture of the soil after a heavy fall of dew or rain. For this reason 5, 8, 10, or 15 per cent must be deducted from the percentage indicated by the pointer, for light rain (snow, fog), moderate rains, and heavy, continuous rains.

In Fig. 16 the hygrometer is registering 57 per cent, the thermometer + 16.8 degrees C.; the corresponding maximum moisture is 14. Hence the absolute moisture is 14 × 0.57 = 8. If we refer to the mark, 8, in the right-hand scale of the thermometer, we find directly opposite in the left-hand scale the corresponding dew-point—in the present instance + 8 degrees C.

The same result can be obtained far more rapidly without any calculation, if the upper scale of the hygrometer (Figs. 16 and 17) be employed. It will be observed that this upper scale is graduated from 1 to 30. In Fig. 16 the central index lies opposite the graduation 8, thereby showing that the dew-point is approximately 8 degrees below the temperature indicated by the thermometer. Or, in other words, the dew-point in the present case is 16.8 — 8 = 8.8 degrees.

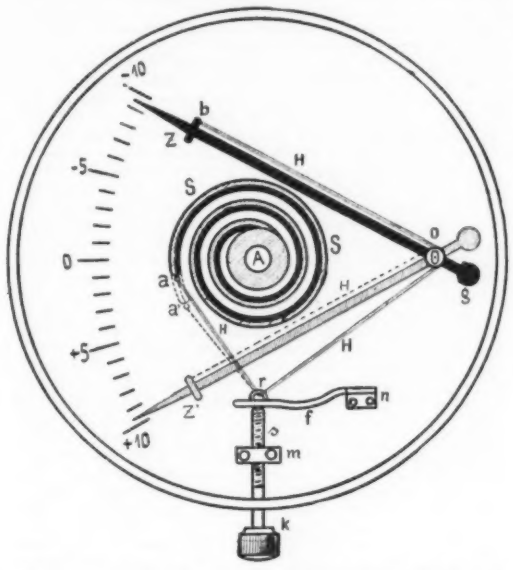

FIG. 18.—DIAGRAM OF THE THERMOHYGROSCOPE.

This result, it will be observed, differs by 0.8 degree from that previously obtained. The error can be much reduced by using the proper index. At a temperature of 0 C. degrees the right index is used; at + 10 degrees C. the central index is used; and at + 20 degrees C. the left index is used. For other temperatures, imaginary intermediate indices are employed. In the example given, the temperature is 16.8 degrees C. An index is conceived between the central and the left index, somewhat nearer the latter (16.8 is nearer 20 than 10), and the opposite-lying graduation read off. The number read is approximately 8.6, which, as before signifies that the dew-point lies 8.6 degrees below the actual temperature (16.8 degrees), and is therefore equal to 16.8 — 8.6 = 8.2 degrees C. The error is now only 0.2 degree.

The importance of determining the dew-point may be seen from the many rules which meteorologists have drawn to assist them in foretelling the weather. A rapid and considerable rise in the dew-point (about 6 degrees C. in 12 hours) is an indication of a distant storm. A dew-point of 17 degrees C. indicates an impending storm. Marked variation of the dew-point is followed usually by high winds. If the dew-point sink to 0 degrees C. or below frost may be expected during the night. If the evening dew-point (that is, the dew-point taken at 6 P. M. from April to August) be greater than the morning dew-point (taken at 8 A. M.), a storm is impending. If the evening dew-point be not more than 4 degrees C. lower than the morning temperature, a precipitation of moisture may be looked for. If the evening dew-point be from 5 degrees to 8 degrees C. lower than the morning temperature, fair weather will probably prevail. If the evening dew-point be 9 degrees C. more or less below the morning temperature, wind and precipitations of short duration may be expected.

It has been remarked that the hair-hygrometer, forming part of the polymeter, indicates not the absolute but the relative moisture of the air. If, for example, the absolute moisture be 3.5 at a temperature of + 6 degrees C. at 8 A. M., the polymeter will indicate 50 per cent; for the relative moisture is 100 × 3.5 ÷ 7* = 50 per cent. If in the course of the next hour the temperature increase to 18 degrees C. and the absolute moisture to 7.7, then the relative moisture = 100 × 7.7 ÷ 15.4† = 50 per cent. The index of the polymeter points in both cases to 50, although the actual, absolute moisture is twice as large as at 8 A. M. It is evident that the polymeter does not tell us whether the actual (absolute) moisture has increased or diminished; and the extent of that increase or decrease. To fill this want instrument makers have devised the "thermohygroscope," shown in Figs. 18 and 19.

FIG. 19.—THE THERMOHYGROSCOPE.

The instrument comprises essentially a double spiral, *S*, of zinc and iron and a prepared strand, *H*, of hair, extending from the end, *a*, of the spiral, through an eye, *r*, over the roller, *O*, to the end of the index, *Z*. The eye, *r*, is carried by the spring, *f*, and is raised or lowered by means of the set-screw, *s*. If the eye be lowered, the strand of hair is subjected to tension, and the index, *Z*, thereby raised. If the eye be raised, the strand of hair is slackened, and the index falls by its own weight. In this manner the index of the instrument is adjusted to 0 every morning at eight o'clock.

The spiral, *S*, operates much in the same manner as the spiral of the thermometer shown in Fig. 3. When the temperature rises from + 6 degrees C. to + 18 degrees C., as in the preceding example, the spiral curves inwardly, so that its free end, *a*, moves downwardly to *a'*. The tension of the strand, *H*, is thereby diminished, for which reason the index falls. Since the relative moisture has remained the same, the length of the strand is not changed. While the polymeter points constantly to 50 per cent, the thermohygroscope, through the falling of its index, shows that

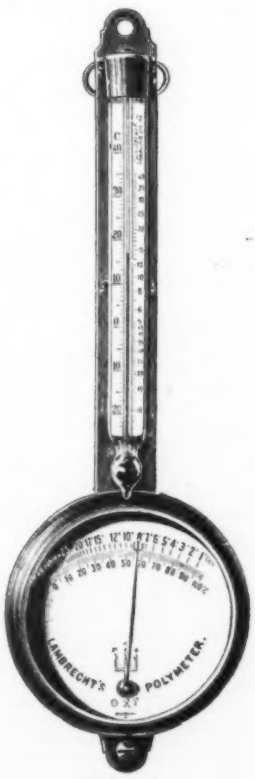

FIG. 16.

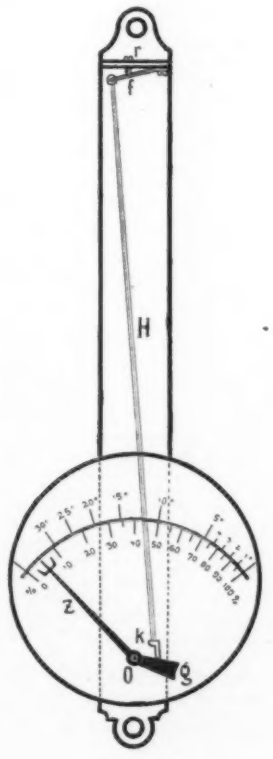

FIG. 17.

LAMBRECHT POLYMETER.

FIG. 20.—THE "WEATHER TELEGRAPH."

* 7 = maximum moisture for + 6° C.
† 15.4 = maximum moisture for + 18° C.

the absolute moisture of the air has increased since eight o'clock A. M. Since the dew-point rises with the absolute moisture, it may be said that a falling of the index of the thermohygroscope corresponds with a rise in the dew-point. The reverse is also true.

But the indications of the thermohygroscope are not alone sufficiently complete to enable the bureaus to forecast the weather. The atmospheric pressure must also be known. For this reason the thermohygroscope is sometimes combined with an aneroid barometer to form the so-called "weather telegraph," illustrated in Fig. 20. To the left the thermohygroscope is located; to the right is a metallic barometer, the index of which, when horizontal, shows the mean barometric height of the station. If the indices of both instruments rise, then atmospheric pressure has increased and the absolute moisture has decreased, from which the observer concludes that good weather may be hoped for. A downward movement of both indices precedes bad weather. Between these two extremes lie the most various combinations of the two indices. These combinations, together with the weather conditions which may follow, are tabulated for the convenience of the meteorologist.

THE NINETEENTH CENTURY IN MEDICINE.*

WHEN the nineteenth century dawned, the medical profession was still dazed, so to speak, with the practice of vaccination, which had been inaugurated only three years before. The discovery was empirical, and so was the practice that followed it. It gave rise to no end of speculation, but not to one jot of that rigorous experimental study that a like occurrence would now occasion. The time was not ripe for its culmination in what are now known as the germ theory of disease and the anti-toxine system of treatment. The profession had not emancipated itself from the "Hippocrates dixit" slavery, though isolated individual effort, notably by such men as Morgagni, had long before paved the way for that rational study of medicine which has characterized the last quarter of the century. Men were content, as a rule, to listen to the plausible; they were even satisfied to sit at the feet of the nosologists and drink down words in lieu of facts. Exposure to cold was accepted as the common cause of acute diseases, and bloodletting, starvation, mercury, antimony and opium were the "sheet-anchors" of therapeutics. Even so late as in the third quarter of the century a professor in one of the leading American medical schools—as conspicuous a school then as it is now—satisfied his classes by reading from the hospital case-books and from the writings of Gendrin and Piorry. This was what was then known, at least in the United States, as clinical teaching. As for didactic teaching, which was almost the only variety of public medical instruction, it was gaged more by the rhetorical powers of the professor than by the purport of what he had to say. Fortunately, the apprenticeship system—for such, virtually, was the relation between the student and the private preceptor—made good some of the deficiencies of the school curricula. The study of gross anatomy was hampered in this country and in some others by scarcity of material, histology was in its infancy, physiology was speculative, pathology was a matter of plausible suggestion; diagnosis, save at length for Laennec's resort to auscultation and percussion, rested almost solely on subjective symptoms, and the treatment of disease was traditional, not to say empirical. "Peritonitis" was prevalent and almost invariably fatal, and a major amputation was well-nigh equivalent to a death warrant.

But through all this period of apparent stagnation influences were at work which were destined to raise medicine from the position of a respectable trade to that of a science ever more and more bordering upon the exact. Auscultation and percussion, the use of the microscope in diagnosis and pathology, uranalysis, Bright's unmasking of dropsy as a disease and his demonstration that it was only a result of disease, Sir Everard Home's varied investigations, Addison's exposition of the disease of the suprarenal capsule that now bears his name, Louis' "numerical method" of studying disease, Trousseau's genius as a clinician and the gradually growing conception of the value of experimental methods of research were preparing the way for the rigid and triumphant medicine of the last quarter of the century now closing. Besides all this, there had been some epoch-making advances. Conservative surgery, as expounded by Syme and Chopart, was growing into recognition, and the doctrine of the self-limitation of certain diseases and the "expectant" method of so-called treatment, barren as they were of immediate results, caused the profession to halt and to take a new start. In the meantime, some startling things had been accomplished; Ephraim McDowell's boldness and success in ovariotomy had slowly come to be recognized as foreshadowing an immense saving of life, and the discovery of anæsthetization by at least two Americans, Morton and Long, independently, had practically done away with anguish under the surgeon's knife and amazingly widened the sphere of operative surgery. But it was not until after all this, together with the introduction of clinical thermometry and the definite abandonment of "lowering measures" in therapeutics, that medicine entered upon its real nineteenth century career. The pivotal events of the century have been the establishment of the germ theory of disease, its culmination in anti-toxine treatment, and, the crowning glory of all, the development of preventive medicine.

Nevertheless, it may not be unprofitable to enumerate some of the individual steps in the advance of our work. As regards gross anatomy, little more is known now than was known to our forefathers of the eighteenth century. In minute anatomy, well-nigh all that we now know has been revealed during the century that is drawing to a close, and we should not forget that we owe much of it to the botanists, whose observations we have been able to adapt to our research into animal structure. The subjects of gross and microscopical anatomy naturally run into that of physiology, and on all three of them embryology sheds a flood of light. The work of the histologist and that of the embryologist have played an extensive part in making our knowledge of physiology what it now is. William Beaumont's careful experimental study of the digestive function of Alexis St. Martin, who was the subject of a permanent gastric fistula, did much to stimulate the precise investigation of physiological processes. Deliberate experiments on the lower animals have, however, been the chief means of advancing our ideas of physiology, but they have been notably supplemented by such studies of the living human organism as have led to what is now held concerning cerebral localization, also by such unintentional experiments as have been involved in certain surgical procedures, removal of the thyreoid gland, for example. But pure reasoning has contributed not a little to shaping the investigations on which our present conception of "internal secretions" rests; let us not forget that Brown-Séquard, ridiculed as he has been for his propositions concerning the therapeutical use of "testicular juice," gave the initial impetus to those investigations. The use of disgusting animal preparations in the pharmacy of bygone centuries rested on no rational basis, so far as we can now ascertain, and it may be said in all fairness that it had nothing in common with the organotherapeutics of the present time. We now know that organs which but a few years ago were of no imaginable use in the economy have very definite functions. This is perhaps, next to phagocytosis and the natural evolution of anti-toxines, our greatest advance in physiology, possibly the very greatest, for phagocytosis and the production of anti-toxines seem to take place only when the system is attacked by the germs of disease.

In the early part of the century nosology was a favorite theme with writers who thought they had a mission. Few of us now give much thought to the nomenclature and classification of diseases, save perhaps the dermatologists. The coinage of new names, to be sure, goes on briskly enough, one would think, to satisfy even the fertile Piorry, and largely along lines not at all preferable to those followed by him, but, happily, there are indications that the profession is tired of the business. The task we set ourselves now is not that of finding a name for a morbid condition, but that of ascertaining its nature and probable course, the means of preventing its aggravation in the particular individual and its spread to others, and the measures that are most likely to carry the patient safely through the illness while allaying his sufferings to the last degree consistent with his ulterior welfare.

In pathology, the old contest between the humoralists and the solidists has been forgotten; in fact, in the whole range of the medical sciences, we long ago perceived the fallaciousness of groping for a law which should be of universal application. We now seek to elicit facts and to understand their relations to each otner. When plausibility and persuasive diction finally ceased their sway, we were left with nothing to cling to in the way of general doctrine, but we were left with a clear field. The incubus was shaken off, and we awoke. Naturally, much time had to be spent in observations that were for the time being almost barren as ground for generalizations, and the tendency to hasty deductions had still to be fought against. But men arose that were capable of laying solid and enduring foundations for the fair edifice, still uncompleted, of modern pathology. The work of Chomel, Louis, Rokitansky, Paget, Gross, Cohnheim, Virchow, Lancereaux, Metchnikoff, Welch, Laveran, Fitz, Councilman, Prudden, Kitasato and a host of others will never be forgotten or undone, for the simple reason that there is nothing speculative about it. The pathologists of the nineteenth century have taught us that typhus, typhoid fever, pulmonary consumption, cholera, yellow fever, the Oriental plague, pneumonia, malignant pustule, tetanus and malarial disease are infective and due each to its individual *materies morbi*, or *contagium vivum*, what early in the century would have been styled a "morbid poison."

So intimately blended are the medical sciences that we can tell the story of modern pathology no further, even in these general terms, without taking up that of ætiology, and that, in turn, is so interwoven with diagnosis, therapeutics and prophylaxis as to prove refractory to all attempts at isolation. However, there are certain salient points of ætiology which deserve mention by themselves. Patrick Manson's demonstration of the pathogenic importance of the *Filaria sanguinis hominis*, preceded by similar work by Van Beneden, Kuechenmeister and Cobbold, has given an impulse to the investigation of morbific parasites that is undoubtedly destined to go on to the solution of many an ætiological problem that still remains unsolved. The germ theory of disease, for which we are really indebted to Pasteur, is unquestionably the fulcrum of the ætiology, pathology and therapeutics of the present day. We no longer, save in a remote sense, attribute disease to the visitation of Providence or exposure to cold; we know that in the great majority of instances disease is due to an invasion from without, and not to perversity on the part of the almost divine organism with which the Almighty has endowed us. Constitutional defects and heredity, in our present view, play but a subsidiary part in ætiology, and "scrofula" is relegated to the lumber-room. The "favorable soil" for disease is a soil made favorable by some defect, usually an acquired one, of the normal resisting powers.

It has been made clear during the century, and chiefly in its closing years, that all the infectious diseases are traceable to living germs, each disease having its specific microbe, and the avenues of contamination with these germs have been so fully explored that comparatively little remains to be done in that direction. It has been shown that typhoid fever is almost exclusively a "water-borne" disease, that we take the germ in with the water we drink. But, complete as the demonstration is, it has been a difficult task to rouse the average man from his sluggish incredulity, and consequently the work of guarding against injurious impurities in our supplies of drinking-water still lags far behind what our civilization demands. It has been shown also that "the harmless, necessary" fly is an active agent in disseminating typhoid fever and certain other diseases, notably malignant pustule and that malaria has nothing to do with "bad air" and is not a baleful emanation from the earth, but is produced solely by Laveran's plasmodium, which is nurtured for a portion of its life history in the organism of certain mosquitoes. Furthermore, there is now good reason to believe that yellow fever is spread by mosquitoes. It has been shown that tetanus is in no wise dependent upon the character of the wound that precedes it, though there is doubtless a misleading truth in the popular impression that "stepping on a rusty nail" is peculiarly apt to be followed by the disease. There is nothing malign in the nail, in the rust, in the punctured character of the wound, or in fact that it is the tendinous structures of the foot that have been injured—there is nothing malign in any one of these things *per se*—the pre-eminence of the rusty nail as an occasion of tetanus is very simply explained; before it can be stepped on, it must generally be situated on the ground, and, when it proves productive of tetanus, on soil contaminated with the germ of the disease. The theory that tetanus is essentially a disease of the horse, fortified as it is by almost conclusive proof that the infection of the disease comes in the great majority of instances from the soil beneath and about a stable, seems likely to be substantiated. It has been shown that osteomyelitis and the other causes of the fearful old-time mortality of major amputations, operations on joints, and those involving abdominal section are due to pathogenic germs. Puerperal fever, declared by Oliver Wendell Holmes and demonstrated by Semmelweis to be the product of infection from without, is now so interpreted the world over, to the enormous saving of women's lives. Destructive diseases of the teeth and their sockets are now traced to pathogenic germs, and it is hardly too much to expect that as a consequence the dentist's art will be practically restricted before long to the saving of the natural teeth in all but traumatic cases. Functional nervous affections of various sorts are largely attributed to peripheral irritation, including "eye strain," and their treatment has accordingly grown more promising. In place of the multitudes who formerly died of so-called "peritonitis," we now see the vast majority of persons who have been attacked walking about in good health, simply because the commonest cause of the disease has been ascertained to reside in the vermiform appendix, an organ that is removed with great facility and with hardly an appreciable mortality. The doctrine of "latent gonorrhœa" as a fertile cause of uterine and other pelvic disease of a painful, disabling, and even dangerous character, proclaimed years ago by Noeggerath, is now commonly accepted, though not, of course, to the exclusion of other sources of infection, and as a consequence more radical measures are resorted to for the cure of those affections, procedures but little dangerous in themselves, although, it must be confessed, often fraught with undesirable mutilation. The ætiology of gonorrhœa itself has led quickly to the Janet treatment, which would otherwise have been indefinitely deferred, with the results that not only is the primary disease speedily cured, but serious complications affecting the joints, the heart and other important structures are prevented.

The art of diagnosis has been notably advanced during the century, both by the recognition of new signs and symptoms and by the adoption of means of investigation previously unknown or unappreciated. Among the former may be mentioned the Cheyne-Stokes type of respiration, the rose spots of typhoid fever, the *tache cerebrale*, derangements of the reflexes, disturbances of muscular co-ordination, Kernig's sign of cerebral meningitis and various abnormities of sensibility. Two of the old routine diagnostic procedures, the examination of the pulse and that of the tongue, have come to be regarded as often of secondary importance. This is especially true in the case of the tongue, and perhaps the tendency has been carried too far. The universal use of the clinical thermometer has doubtless been the chief reason why the pulse has been somewhat neglected of late years, except in cases calling for something more precise than the *tactus eruditus*.

Auscultation and percussion, although supposed to have been practiced to some extent by Hippocrates and perhaps by others of the ancients, were, nevertheless, devised and systematized by Laennec comparatively early in the century. With uranalysis, they undoubtedly constitute the most important diagnostic means introduced during the century, on account of the frequency with which we are compelled to resort to them, if for no other reason. All of them have been brought to great precision, a nicety more striking perhaps in the case of uranalysis by reason of ureteric catheterism and of the association of urinary examinations with the various procedures for ascertaining the particular portion of the urogenital tract from which certain morbid products proceed. Side by side with them, clinical microscopy has progressed to such importance that no man can now practice medicine in a manner to be tolerated in a civilized community without constant recourse to it.

Clinical thermometry came in the third quarter of the century, and its infinite superiority to interrogation of the pulse was quickly demonstrated. Doubtless the use of the thermometer has occasionally given rise to needless alarm, but almost invariably it may be interpreted with great certainty. Often it dispels unnecessary anxiety as in a twinkling by its negative indication, and surely it is to be credited with being distinctly diagnostic in those diseases of which it has itself established the "curve." He who should now attempt to understand the nature and probable course of acute illness without the aid of the thermometer would find himself hopelessly handicapped; one might almost as well trust to subjective symptoms, to the vague and inaccurate stories of the sick and their friends. Examination of the blood and the counting of its red and white corpuscles are now of such recognized value that they figure in a very large proportion of case histories, and the recognition of the *Plasmodium malariae* in its various phases is a *sine qua non* in the precise diagnosis of malarial diseases. Ehrlich's "diazo" reaction and Widal's agglutination test have materially augmented the data of precision in the diagnosis of typhoid fever.

* New York Medical Journal.

But it is in the diagnosis of morbid conditions by the employment of special instruments that more numerous advances have been made. Ample notions of their number and of the great aid they render in the recognition and often in the treatment of disease may be gathered from a mere enumeration of the more important of them. We may therefore rest content with mentioning Nélaton's porcelain-tipped probe, Girdner's telephonic probe, the æsthesiometer, the cyrtometer, the ophthalmoscope, the ophthalmometer, trial glasses, the laryngoscope, the Eustachian catheter, the sphygmograph, the gastric douche, the diaphanoscope, Turck's gyromele, the urethroscope, the urethrometer, the bougie à boule, the cystoscope, the ureteral catheter, the vaginal speculum, Simpson's uterine sound, Sims' uterine probe, the anal speculum, the proctoscope, electrical apparatus for detecting nervous and muscular reactions or their absence, exploratory puncture, the aspirator, and the Roentgen-ray apparatus. Add to all these resources exploratory abdominal section, now employed with but little danger, and we are giving a sufficient picture of the great strides made in diagnosis during the century.

Chemistry, pharmacology, and pharmaceutics have not lagged behind in the march of improvement. The isolation of the active principles of medicinal plants has led the way to drugs of definite strength as well of less repugnant properties, and these active constituents, together with a great number of synthetical products, have enabled us to produce palliative and curative effects before impossible of achievement. Morphine and codeine, for example, are far more to the purpose in many a case than the crude drug from which they are extracted, and the same is true of quinine, strychnine, atropine, eserine, pilocarpine, and cocaine—of the last-mentioned pre-eminently—also of many other natural alkaloids and glucosides. The introduction of cocaine as a local anæsthetic by Koller proved an immediate boon to sufferers with eye troubles, and the rapid extension of its use to surgical procedures the most diverse has been almost as satisfactory. Its use within the membranes of the spinal cord, to produce anæsthesia of the lower portion of the body, devised by Corning, is still *sub judice;* in previous issues we have said all that we can say at present concerning it. The employment of atropine or of some substitute for it in ophthalmic practice could not be dispensed with, and the varied usefulness of the drug in other fields is hardly less pronounced; it would remain invaluable if it had no other virtue than its life-saving power in many cases of mushroom poisoning.

Of the numerous artificial products, chloral hydrate came first, and it was at once shown to have soporific properties quite foreign to safe doses of any hypnotic previously known. Then came antipyrine, acetanilide, and the host of synthetical antipyretics and analgetics that have come into more or less general use. The speedy reduction of a febrile temperature as the result of a single dose of a drug had not been dreamed of before. Apormophine, a quick and sure emetic, has saved many a life that was in imminent danger from the ingestion of poison, having the unique advantage of acting when used subcutaneously, so that unconsciousness on the part of the patient is no bar to its employment. Many hypnotics, notable among which is trional, have been introduced since chloral came into use, and they have proved to be preferable to that drug in many conditions, as well as safer.

Numerous antiseptics have come to be used during the last few years. Among the first was iodoform, a malodorous drug which seems now to be meeting with depreciation that is not wholly deserved. Carbolic acid, Lord Lister's original antiseptic, is still in extensive use, but the spray has properly been abandoned. An important safeguard in the employment of the acid, pure or in strong solution, has been furnished by Powell's discovery that strong alcohol, applied at once, prevents its poisonous action.

The older articles of the materia medica have been subjected to fresh investigation. Notable among the results are those that seem to have sprung from Credé's experiments with metallic silver and certain colloid compounds of that metal, tending to show that they have decided germicidal virtues and to suggest that Sims' early successes in the treatment of urogenital fistulæ were truly in some measure due to his use of silver wire as a material for sutures. Digitalis is one of the old drugs that have been made the subjects of repeated investigations, and as a consequence our use of it and of its different proximate principles is now far more rational and effective than it was some years ago. In a few instances a distinct gain has been achieved by restricting the use of a drug. For example we no longer look upon ergot as a *pulvis ad partum* (deservedly declared to be equivalent to *pulvis ad mortem*), but we reserve its use, so far as obstetrics is concerned, for the third stage of labor and for a brief period following the completion of delivery.

(To be continued.)

BIOLOGY OF CRYSTALS.

FROM biology to the structure of crystals seems a far cry, but those who have penetrated farthest in the study of organisms have time and time again come to the borderland of the inorganic realm, says The American Naturalist. Most have declined to go over into the untraveled domain of a foreign country. Prof. Buetschili is not one of these. (Buetschili, O. Untersuchungen ueber Microstrukturen des erstarrten Schwefels, nebst Bemerkungen ueber Sublimation, Ueberschmelzung und Uebersaettingung des Schwefels und einiger anderer Koerper. Liepzig, Engelmann, 1900.) His studies on the structure of protoplasm are the most profound that have been made. They led him to recognize a single fundamental protoplasmic structure—the alveolar or "foam" structure—of which the karyokinetic figures are only special expressions. At the time of his early discoveries there were few inorganic substances which were known to have any such structure. Emulsions alone were comparable. Studies of starch, cellulose and chitin revealed to Buetschili a similar alveolar structure, and now he has continued his researches into crystals of sulphur and certain salts and finds here the same structure. The protoplasmic structure is, then, not something peculiar to living substance, but is probably characteristic of substance in general—at least of changing, forming, growing substance. Moreover, in the forming crystal we have radial lines proceeding from a center, and these are structurally like the radiations of the asters—like, because due in both cases to a central pull exerted on an alveolar structure.

The vast mass of the work deals with matters of interest, first of all, to crystallographers and physical chemists—the microscopic details of crystal formation, the polymorphism in crystallization, the determination of the polymorphic form by external conditions. These are matters which will be eagerly read by the biologists also, a few years hence, when the close and fundamental relations between organic development and crystalline development become more generally appreciated.

[Continued from SUPPLEMENT, No. 1308, page 20965.]

RECENT SCIENCE.*

II. INSECTS AND MALARIA.

FEW human diseases are so widely spread and few so much paralyze the vital forces of man as malaria does, both in its distinct and its insidious forms. At the same time, it is also one of the greatest obstacles to colonization. Its ravages among the settlers in new countries, before the thickets in the woods have been cleared and the ponds and marshes have been dried, are simply incalculable; and one could lately read in a monograph on malaria in Caucasia that this disease, which is at its worst in the low and fertile portions of that territory, has contributed more to the repulse of invaders than even the inaccessible mountains themselves.[42] Even in civilized countries, and especially in Italy, millions of acres of fertile land lie waste on account of the ague. It is easy, therefore, to understand of what an importance is the discovery of the parasite which occasions malaria, of its modes of propagation, and of the main agents of infection—the gnats.

It was the French doctor, Laveran, who, after a stay in a deadly malarial region of Algeria, discovered the malaria parasite in 1880.[43] True, that pigment cells, which we should now describe as malaria parasites, were observed in human blood as early as 1835, among others by Virchow; but their relation to the disease was not known. In 1881 Laveran embodied his researches in a book,[44] but its importance was overlooked. Bacteria attracted then general attention, and Laveran's parasite, not being a bacterium, was little thought of. He stuck, nevertheless, to his discovery, and was soon joined in his researches by Golgi (the Italian professor to whom we owe the method that led to the discovery of the neurons), as also by Marchiafava, Celli, Councilman, Sternberg, and the Viennese doctor, Mannaberg, who published in 1893 a full compendium of these researches.[45] Dr. Mannaberg proved in this book that the real cause of malaria is Laveran's parasite, and he told its most interesting life-history so far as it was then known.

The parasite of malaria is not a bacterium. It is one of the protozoa—namely, as it appeared later on, a coccidium, which, like all other members of that family, undergoes in its development a series of transformations. It appears first as an amœba developed from a spore, and, like all amœbæ, it protrudes pseudopodia and moves about. It is adapted to life within a red corpuscle of the blood, upon which it feeds and which it gradually destroys, leaving in a vacuole of its body its waste produce in the shape of characteristic dark pigment spots. It soon fills up nearly the whole of the red corpuscle, and then begins to subdivide into from six to twenty sectors, grouped round a central pigment mass like the petals of a flower. These sectors gradually grow round, separate, and each of them becomes a spore which gives origin to a new amœba; and this process of reproduction continues so long as the fever keeps hold of the patient. When the subdivision of the amœba begins, there begins also the paroxysm of the fever—once every twenty-four hours, or once every second, third, or fourth day. This was fully proved, and it appeared, moreover, probable that the diurnal, bidiurnal, tertian, and quartan malaria were characterized each by a special variety of the same parasite.

Another important observation was made by Laveran, and next by Golgi. Besides these amœboid bodies Laveran saw that some parasites (*corps a flagelles*) would send out thin and long flagella which soon parted company with the mother body, and, owing to a proper helicoidal movement, disappeared in the plasm of the blood. This never happened, however, in the body of man, but only when a drop of his infected blood was drawn and placed on the glass plate under the microscope. Laveran noticed, moreover, minute "crescent-shaped bodies" which adhered to the red corpuscles and looked very much like cysts, protected by a harder envelop. From fifteen to twenty minutes after these bodies had been placed under the microscope, they also gave origin to a great number of "flagella;" and this evolution, too, he remarked, seemed to be accomplished only when the cysts were taken out of the human body.

It was only natural to conclude from these observations that the further development of the flagella may take place in the body of some other animal than man, and this consideration brought Laveran, in a book which he published in 1884, to the idea that, taking into consideration the quantities of mosquitoes in malarial countries, they may be the agents of transition of malaria.[46]

This remark passed, however, unperceived. Many had the suspicion that gnats may play some part in the inoculation of malaria: the Italian peasants always thought so, and in the medical literature an American doctor, Mr. King, had advocated the same idea. But the complete life-history of the malaria parasite being not yet known fifteen years ago, the necessity of the mosquito or of some other living being serving as a host for the completion of the reproduction-cycle was not understood. Consequently, little attention was paid to the subject.

Help came now from a different quarter—namely, from an extensive series of researches which were made into the modes of reproduction of the tiny unicellular organisms, or protozoa, and especially of one of them, a coccidium which infests sometimes the epithelium cells of the intestine and the biliary canals of the rabbit. It would be too long to tell here the history of these memorable researches, inaugurated by R. Pfeiffer in 1892,[47] and continued by Simond, Léger, Siedlecki, Schaudinn, and many others.[48] Sufficient to say that two sorts of reproduction were found with this coccidium. One is similar to that just described for the malaria parasite. The coccidium grows, and then subdivides into sectors, each of which becomes a spore giving origin to a new individual. This is its simplest mode of reproduction; but there is also a more complicated one, during which a portion of the cells store a great quantity of materials, in order to give origin to minute cells playing the part of ovula in higher animals; while the others give origin to little lively bodies provided with flagella, which unite with what might be named the ovula of the former, and after that cover themselves with a protective layer, thus forming a cyst. These cysts are evacuated, and, after having been swallowed by another rabbit with its food, they give origin to spores, from which the original parasite is born.

A perfect analogy was thus established by this great biological discovery between reproduction in higher animals, and one mode of it in the lowest and simplest unicellular organisms.

Exactly the same thing was found later on with the malaria parasite. Its simpler reproduction we have seen; but it has also a more complicated mode of reproduction during which some of the crescent-shaped bodies will be filled with what corresponds to ovulæ, while the others give origin to tiny organisms provided with flagella which join the ovulæ and form "oocysts." This process, however, seldom, if ever, takes place in the warm blood of man. It seems to require a cooler medium to stimulate it, and this medium is offered in the intestine of a gnat, after it has sucked the blood of a malaria patient infected with crescent-shaped bodies. The copulated cyst then furrows itself into the epithelium of the gnat's intestine; it grows and then bursts, giving origin to numerous spores ("sporozoites"), which are carried by the lymph to the salivary glands of the gnat; and when the insect next sucks a man's or bird's blood, it introduces the sporozoites into the blood of its victim. Malaria follows; but without the gnat, in whose intestine one phasis of the life-history of the parasite is accomplished, malaria would not be transmitted so easily from one sick person to another.

For simplicity's sake I have given here the whole process as it is understood nowadays. But it is evident that when these researches were still in progress, it was the discovery of the complicated life-history of the coccidia which gave support to the mosquito hypothesis.[49]

Then another group of researches also helped it. Danilewsky had noticed in 1890 the existence of a unicellular parasite, quite similar to Laveran's, in the blood of birds. Sakharoff continued his work in 1893, and Prof. W. G. MacCallum and E. L. Opie undertook to study for this purpose American birds.[50] They found in them both the just mentioned forms of the malaria parasite; the amœba-like being multiplying by subdivision and probably producing the fever which is said to recur in birds every third or fourth day, and also the cells provided with flagella. MacCallum even saw under the microscope that sort of reproduction which Schaudinn and Siedlecki saw so distinctly with the coccidia.

More decisive steps could now be taken to verify the mosquito hypothesis. It was indorsed by Dr. Patrick Manson, who had demonstrated the part played by the gnat in the transmission to man of a filaria, and he induced, in 1895, Surgeon-Major Ross, of the Indian Medical Service, to verify that hypothesis. On the other side, a society for the investigation of malaria was formed in Italy, and the Italian explorers of malaria, Celli, Grassi, Bignami, Bastianelli, and Dionisi, as also Dr. R. Koch, continued their work in the ague-stricken provinces of Italy. Dr. Ross conducted his inquiry in South India in a truly admirable scientific spirit. For two years in succession he used to breed mosquitoes from the pupæ and to feed them on the blood of malaria patients, hunting afterward in their organs for a parasite similar to the malarial "hemamœba" of man. He had already dissected a thousand of the brindled and gray mosquitoes—but in vain. One can easily imagine what it means dissecting a thousand gnats under the microscope, hunting for parasites in the epithelial cells of the gnats' intestines. And yet Dr. Ross did not abandon his work. At last, in August, 1897,

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* Prince Kropotkin, in The Nineteenth Century. Reprinted by permission of the Leonard Scott Publication Company.

[42] Pantukhoff, in Caucasian Calendar for 1899.

[43] Ten years before, Ray Lankester had discovered a similar parasite in the blood of batrachians.

[44] Nature parasitaire des accidents de l'impaludisme, Paris, 1881.

[45] Dr. J. Mannaberg, De Malariaparasiten, Vienna, 1893.

[46] Traite des fievres palustres, 1884; also Dr. F. Mesnil, in an elaborated paper on "Coccidies et paludisme," in Revue Generale des Sciences, 1899, Nos. 6 and 7. I follow Dr. Mesnil in these lines.

[47] R. Pfeiffer, Beitrage zur Protozoen-Forschung: I. Die Coccidien-Krankheit der Kaninchen, Berlin, 1892. Koch's mosquito-hypothesis of malaria, p. 22.

[48] A bibliography of these works will be found in the already mentioned article by Dr. F. Mesnil, in Revue Generale des Sciences. Schaudinn's researches were published in the Abhandlungen of the Berlin Academy, 1898, and in Sitzungsberichte der Ges. der naturf. Freunde, Berlin, 1899, and were fully analyzed by Dr. Koenen in Naturwissenschaftliche Rundschau, 1900, vol. xv., 4 sq.

[49] Several books were published about that time, besides L. Pfeiffer's work, in order to familiarize doctors and veterinarians with these researches. Wasielewsky's Sporozoenkunde, Jena, 1896; G. Schneidemuhl's Die Protozoen als Krankheitsreger des Menschen und der Hausthiere, Leipzig, 1898; and Dr. Manson's Tropical Diseases, 1898, deserve special mention. Dr. Laveran also published a work, Traite du paludisme, Paris, 1897, which contains a full bibliography of the subject. English translation, 1893, by J. W. Martin.

[50] Prof. MacCallum, in Journal of Experimental Medicine, 1898, vol. iii., 103, 117; E. L. Opie in same periodical, iii., 79.

he found in two individuals of the large dapple-winged species epithelial cells containing the characteristic malarial pigment. Preparations of these cells were sent to London and were recognized by specialists, including Laveran, as rendering the discovery of malarial parasites in gnats very probable.[5]

Prof. MacCallum's discovery having been published in the meantime, Dr. Ross, now transferred to Calcutta, directed his researches toward the malaria parasites of birds.[52] Some birds, as is known, suffer from malaria. Consequently, out of thirty healthy gnats raised from pupæ, ten were fed on much infected sparrows, ten on less infected ones, and ten on quite healthy birds. The results this time were most satisfactory. The malaria parasites were found in the gnats, and their evolution was followed as far as the presence of the "sporozoites" in the salivary glands of the gnats.[53]

There then remained only to see whether infected mosquitoes would transmit the infection to birds. This was also done by Dr. Ross. He took about a hundred sparrows whose blood was examined beforehand and found free of malaria parasites. Half of them he then brought in contact with infected mosquitoes under a special net, while the other half he guaranteed from a contact with the gnats. Four-fifths of the first lot had their blood infected with the malarial proteosoma, but none of the second lot; however, when the birds of this lot were also exposed to the bites of the infected gnats, they also got the parasite in the same proportion.[54] The proof was thus conclusive; and when the Italian explorers, as also Koch, repeated Ross's experiments on birds, they fully confirmed them.

The Italian explorers now made in their turn a further step.[55] They cultivated the malaria parasite of man in mosquitoes (*Anopheles claviger*) and studied the full cycle of its reproduction, as it has been told on a preceding page.

They made experiments in order to infect men with malaria through the intermediary of gnats. Several persons who had never before suffered from malaria —among them the explorers themselves—volunteered to sit in a room in which mosquitoes caught in malarial regions had been set free, and to be bitten by them. Some of these persons passed through the ordeal without infection, but others really got the disease, and one of them took it in a very heavy form. On the other hand, when Grassi with a family of workers who had come for work to an extremely malarial district, bringing with them their five small children (children are especially liable to get malaria), slept eight nights during the worst malarial season with an open window protected by a wire grate which excluded gnats, none of them caught the disease.[56]

Then Grassi undertook a study—not yet terminated —in order to see which species of gnats, in different parts of Italy and in Sicily, carry with them the infection. The big *Anopheles claviger*, quite common in the worst malarial districts, proved to be the chief culprit. As to the common species, *Culex pipiens*, which was very much suspected of mischief, it proved, on the contrary, to be innocent as regards man; it carries about the bird parasite but not that of man. Besides, Dionisi discovered the human parasite of malaria in some bats.

Further evidence now accumulated at a rapid pace owing to the combined energies of both the Italian Society for the Study of Malaria and the London and Liverpool Schools of Tropical Medicine. In order to prove that gnats are the chief agents in the spreading of malaria—not air, drinking-water, or emanations from marshes—it was necessary to show that men protected from gnat-bites could live during the bad season in a malarial district without catching the disease. Consequently Dr. Sambon and Dr. Low, of the London School, chose a most malarial and marshy spot in the Roman Campagna, near Ostia, and volunteered to stay there during the worst part of the malarial season in a gnat-proof hut, retiring to it one hour before sunset and not leaving it before one hour past sunrise. The experiment was quite successful; on September 13 both were found by Grassi in excellent health. As to Grassi, he made his experiment on a grand scale. He induced 104 railway employés who stayed with their families in ten railway cottages in the deadly malarial district of Capaccio, near Salerno, to strictly follow his instructions—that is, to retire to their cottages, rendered gnat-proof, at the same hours and to otherwise protect themselves from gnat-bites. Several of them had previously suffered from malaria; nevertheless, on September 16 only three persons out of the 104 had contracted the illness.[57]

And, finally, the members of the malaria expedition of the Liverpool School, who had been sent under Dr. Elliott to Nigeria, after having spent there four months, living practically among marshes and in places regarded as deadly malarial, returned all in perfect health. Their only precaution was the careful use of the mosquito nets at night.

The counter-experiment, already made in Italy, was repeated in London under still more convincing circumstances. Gnats fed under Prof. Bastianelli's supervision on the blood of a sufferer from malaria at Rome, were sent last July to London. A son of Dr. Manson volunteered to submit to their bites, and soon was suffering from a distinctly malarial infection; the microscopic examination of his blood showed the presence in it of the malarial parasite.

Such is the present state of these researches. They certainly do not prove that there are no other causes of malarial infection but the bites of insects; but they strongly militate in favor of the assertion that insects' bites are the main agents in spreading the infection, and that all measures should be taken for the destruction of gnats in small pools and marshes near human dwellings, as well as all measures of protection from gnat-bites. With the plague at our doors, and the certitude that rats, mice, flies, gnats, fleas, etc., are active agents of its propagation, this discovery acquires a wide importance. As to the researches themselves, they offer an admirable illustration of the combined work of pure science and applied science, as well as of the international character of science divested of national rivalries.

[51] British Medical Journal, December 18, 1897, p. 1788. Dr. Ross's letter was followed by notes by Dr. Manson, Bland Sutton, and Dr. Thin. A further communication of Ross to the same journal (February 26, 1898, p. 550) announced the discovery of the same cells in two more gnats.

[52] Dr. Manson, in the same periodical, June 18, 1898, p. 1575.

[53] See Dr. Manson's address before the British Medical Association at Edinburgh in July, 1898 (British Medical Journal, September 24, p. 849). Dr. Daniels's report about his visit to Dr. Ross, and the researches they made upon Ross's specimens for determining the life-history of the parasite, is full of deep interest (Nature, August 3, 1899, lx., p. 332).

[54] Dr. Ross's lecture before the Royal Institution, March 2, 1900 (Nature, lxi., p. 522), in which all the exploration is told in detail.

[55] B. Grassi, "Cultivation of the Crescent-shaped Malaria Parasite of Man in a Mosquito (Anopheles claviger)" and "On the Spreading of Malaria by Mosquitoes," in Rendiconti of the Academy dei Lincei, November, 1898; Grassi, Bignami, and Bastianelli, "Further Researches into the Development-cycle of the Malaria Parasite of Man in the Body of Mosquitoes," Rendiconti, December, 1898; Grassi and Dionisi, "Development-cycle of Hæmosporides," December, 1898; Celli's "Yearly Report of the Italian Malaria Society for 1898," in various periodicals.

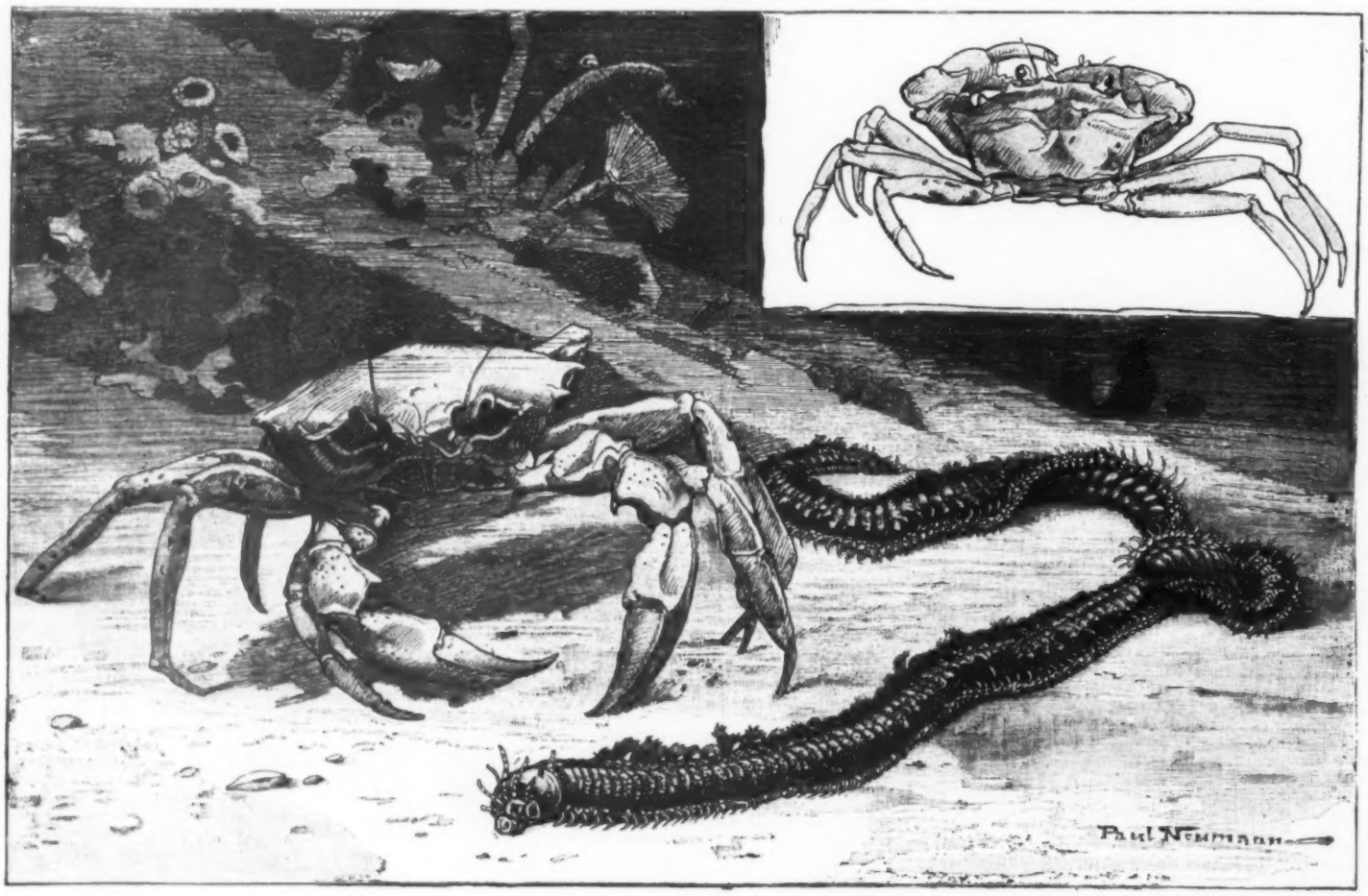
[56] Paper read at Munich in September, 1899, before the German Association.

[57] Nature, October 11, 1900, vol. lxii., p. 578.

A SCANDINAVIAN CRAB AND A MARINE WORM IN THE BERLIN AQUARIUM.

UNDER the generic term "worm" the average man includes any creature that is reasonably long, that writhes and twists itself in almost every conceivable shape. Unfortunately, his knowledge of worms is limited to the blind earth worm and the leech—both, it must be confessed, not very attractive forms. He knows nothing of the worms that live in the sea—worms of such magnificent form, of such gorgeous color that they have been called "muses," "nymphs" and "graces." Our engraving, taken from the Illustrirte Zeitung, pictures one of these beautiful worms of the genus *Eunice*.

The worm is somewhat more than a yard long, about as thick as one's finger, and has more than 300 legs. Surrounding the mouth are five long feelers. The gills appear on both sides as incessantly moving feathers of rusty brown color. In worms which are blessed with a few hundred legs, the muscular system is marvelously well developed. Bundles of muscles extend into the organs of locomotion, the lateral protuberance, and the spines. Creatures of this kind are often hauled up by dredges near the zoological station of Rovigno, on the Adriatic Sea. The specimen now in the Berlin Aquarium came from Rovigno, where it had lived for some time in captivity. During the day it conceals itself in the sand, its head alone being visible. At night it crawls out to eat the meat which constitutes its chief nourishment.



SCANDINAVIAN CRAB AND A MARINE WORM IN THE BERLIN AQUARIUM.

Another interesting maritime specimen in the Berlin Aquarium is the red Scandinavian crab (*Geryon tridens*), distinguished by the red head-piece, with its three spine-like teeth, projecting laterally. At the very slightest touch, the creature withdraws its eyes into recesses or sockets.

SIMPLE WEHNELT INTERRUPTER.—J. von Pallich describes a form of Wehnelt interrupter in which the lead plate is replaced by a copper wire, and the platinum anode by a steel wire. Both wires are inclosed in glass tubes, that containing the steel wire being strong, and tightly surrounding the steel tip. Both wires dip into dilute sulphuric acid. The steel wire is 1 mm. or 2 mm. thick, and its upper end is held in a cork provided with a cup for a mercury contact. The vessel containing the sulphuric acid is surrounded by cold water to keep the temperature down. The two glass tubes with their wires are inserted in a rubber stopper provided with borings to allow the acid to flow

back into the bottle in case it spurts out. A curious phenomenon noticed in the working of the instrument is that the steel wears away just where the wire emerges from the glass tube, and not in the portion more immersed in the acid. A constriction is thus formed, and the effect appears to be that its formation assists rather than retards the generation of the gaseous layer, the explosions becoming stronger and more abrupt as the work of the interrupter continues. The double adjustment possible in this type of instrument makes it particularly easy to obtain the necessary current strength.—J. von Pallich, Ann der Physik, No. 11, 1900.

PENDULOUS TREES.

WEEPING trees are always striking, not unfrequently highly decorative, but sometimes merely quaint or odd. The weeping birch and the weeping willow are models of elegance, says The Gardeners' Chronicle; the weeping spruce, or that form of it known as monstrosa, is an exemplification of all that is grotesque. In some cases, as in Cupressus funebris and C. Nootkatensis (Thuiopsis borealis of gardens), the main stem is erect, and only the ultimate branches are pendulous. In one form of the common spruce the general shape of the tree is columnar, the upper branches being erect and closely pressed up against the stem, while the lower ones are bent downward and equally appressed to the main trunk. Now, what can be the cause of so diametrically opposite a condition of affairs in the same tree?

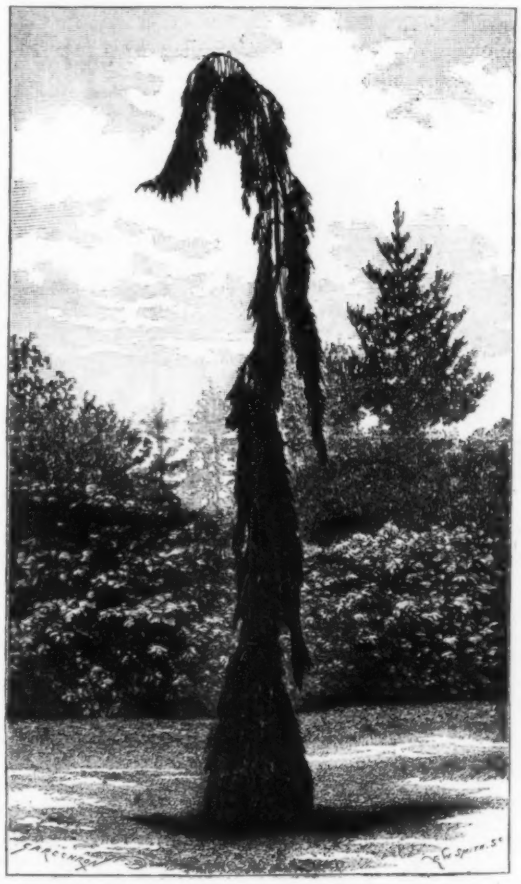
These variations in the phenomena witnessed do indeed render their explanation very difficult. We might suppose that the weight of the leaves had something to do with the downward direction of the branches, or that the recurved twigs facilitated the passage of the rain-drops to the roots; or we might attempt to conceal our ignorance by saying that it was due to gravitation or geotropism, or "apo-geotropism," as the case may be. But even supposing these Græco-Latin words conveyed a certain amount of truth, they would not and do not account for all the conditions. It is only here and there that we find weeping trees, but gravity and geotropism are universal phenomena. The weeping chrysanthemum shown before a recent meeting of the Scientific Committee of the Royal Horticultural Society was the first of its kind that has been seen or recorded. How and why did it arise? We must be humble, and say we do not know.

Regarded from a decorative point of view, we may mention, in addition to those above named, as specially worthy of attention Thuya filifera of gardens, the weeping form of Cupressus pisifera; the weeping larch, of which a fine specimen from Messrs Young's nursery at Milford was illustrated in our columns on April 7, 1888; the pendulous Sophora is also very characteristic, and, if not overdone, is very effective on lawns. The weeping form of the common mountain ash is too straggling to be considered ornamental, but, as a curiosity, it may be used with discretion. Weeping ashes, willows, birches, poplars and elms are favorite subjects for the adornment of parks and pleasure-grounds; the pendulous Laburnum is less commonly met with. No one who has seen the gigantic beech at Mr. Anthony Waterer's, or that at Messrs. Smith's nursery at Worcester, is likely to forget their impressive appearance.

To show how apparently capricious this weeping tendency is, we may extract the following passages from Darwin's "Variations of Animals and Plants":

"The weeping or pendulous growth of trees is strongly inherited in some cases, and, without any assignable reason, feebly in other cases. I have selected this character as an instance of capricious inheritance, because it is certainly not proper to the parent-species, and because, both sexes being borne on the same tree, both tend to transmit the same character. Even supposing that there may have been in some instances crossing with adjoining trees of the same species, it is not probable that all the seedlings would have been thus affected. At Moccas Court there is a famous weeping oak; many of its branches 'are 30 feet long, and no thicker in any part of this length than a common rope. This tree transmits its weeping character, in a greater or less degree, to all its seedlings; some of the young oaks being so flexible that they have to be supported by props, others not showing the weeping tendency till about twenty years old. Mr. Rivers fertilized, as he informs me, the flowers of a new Belgian weeping thorn (Cratægus oxyacantha) with pollen from a crimson not-weeping variety, and three young trees, 'now six or seven years old, show a decided tendency to be pendulous, but as yet are not so much so as the mother plant.' According to Mr. MacNab, seedlings from a magnificent weeping birch (Betula alba), in the Botanic Garden at Edinburgh, grew for the first ten or fifteen years upright, but then all became weepers like their parent. A peach with pendulous branches, like those of the weeping willow, has been found capable of propagation by seed. Lastly, a weeping and almost prostrate yew (Taxus baccata) was found in a hedge in Shropshire; it was a male, but one branch bore female flowers, and produced berries—these, being sown, produced seventeen trees, all of which had exactly the same peculiar habit with the parent-tree.

"These facts, it might have been thought, would have been sufficient to render it probable that a pendulous habit would in all cases be strictly inherited. But let us look to the other side. Mr. MacNab sowed seeds of the weeping beech (Fagus sylvatica , but succeeded in raising only common beeches. Mr. Rivers, at my request, raised a number of seedlings from three distinct varieties of weeping elm, and at least one of the parent-trees was so situated that it could not have been crossed by any other elm; but none of the young trees, now about a foot or two in height, show the least signs of weeping. Mr. Rivers formerly sowed above 50,000 seeds of the weeping ash (Fraxinus excelsior), and not a single seedling was in the least degree pendulous. In Germany, M. Boachmeyer raised a thousand seedlings with the same result. Nevertheless, Mr. Anderson, of the Chelsea Botanic Garden, by sowing seed from a weeping ash, which was found before the year 1780, in Cambridgeshire, raised several pendulous trees. Prof. Henslow also informs me that some seedlings from a female weeping ash in the Botanic Garden at Cambridge were at first a little pendulous, but afterward became quite upright; it is probable that this latter tree, which transmits to a certain extent its pendulous habit, was derived by a bud from the same original Cambridgeshire stock; while other weeping ashes may have had a distinct origin. But the crowning case, communicated to me by Mr. Rivers, which shows how capricious is the inheritance of a pendulous habit, is that a variety of another species of ash (F. lentiscifolia), which was formerly pendulous, 'now about twenty years old, has long lost this habit, every shoot being remarkably erect; but seedlings formerly raised from it were perfectly prostrate, the stems not rising more than two inches above the ground.' Thus the weeping variety of the common ash, which has been extensively propagated by buds during a long period, did not, with Mr. Rivers, transmit its character to one seedling out of above twenty thousand; whereas the weeping variety of a second species of ash, which could not, while grown in the same garden, retain its own weeping character, transmitted to its seedlings the pendulous habit in excess!"



WEEPING SPRUCE AT IDE HILL, SEVENOAKS

SOPHORA JAPONICA PENDULA.

ACTION OF TERRESTRIAL MAGNETISM ON THE RATES OF CHRONOMETERS.

IN the issue of the Comptes Rendus of the Paris Academy of Sciences for November 26, vol. cxxxi., pp. 859-865, there is an important communication by Prof. A. Cornu, dealing with an experimental investigation of the action of a terrestrial magnetic field on the rate of a magnetized chronometer.

The observations have been carried out on a pocket half-chronometer, provided with anchor-escapement, compensated balance and palladium spiral, whose rate had previously been very satisfactory, but which had inadvertently become magnetized by a large electromagnet. The generally prevalent idea is that a magnetized watch is quite untrustworthy until it has been completely demagnetized, but the author's research has convinced him that there is evidence of a regular law in the rate of such an affected timepiece, and therefore it should be possible to neutralize the disturbance, either by tables of correction formulæ, or by suitably disposed compensators.

The magnetizable parts are the pivots, anchor, spring, balance-wheel and accessories to the escapement. In watches of precision all direct contacts between steel parts are avoided by the use of hard stone bearings, so that the mutual actions are inductive effects. If, then, the watch be laid on a horizontal table at a definite orientation, the only disturbing external force capable of affecting its rate will be the terrestrial magnetic field. To test this, provision was made for varying the orientation of the balance by making the horizontal support movable about a vertical axis, and then keeping the watch or clock for several days successively in the four positions corresponding to the hours XII, III, VI, IX, pointing respectively to the Magnetic North.

Systematic observations from 1898, June 20, to 1900, November 17, furnish a series of values for the variations in rate at the four orientations, and the discussion of them has enabled Prof. Cornu to show that they may be represented by a sinusoid. The magnetic state of the watch remains sensibly constant; the semi-amplitude of the variations with the orientation was 10.37 secs., and the mean azimuth of the ascending node of the sinusoid about 260 degrees 21 minutes. This result is especially interesting and important in that this sinusoidal law is identical with that obtaining when a watch having a balance wheef slightly out of equilibrium is hung with its dial vertical and oriented to different azimuths. That is, gravity also produces, if the mean amplitude remains constant, a couple proportional to the vertical projection of the eccentricity of the center of gravity. Here a series of observations of the rate of the same watch before it was magnetized are given, taken during the period 1890 October 26, 1891, January 25, showing the fulfillment of the sinusoid law in this respect.

It would thus appear that the condition discovered by Phillips (Annales des Mines, 6th series, vol. ix., p. 321, 1866) for eliminating the disturbance due to gravitation may also be applied to the compensation for magnetization.

As a crucial test of the truth of his deductions, Prof. Cornu performed a substitution experiment in which the earth's magnetism was directly allowed for. In a piece of cork of exactly the same form as the watch a cylindrical hole was cut in the position corresponding to the balance wheel. In this was supported a small compass needle, and the whole supported on a horizontal table. By means of a jointed arm a bar magnet was held in such a position that the earth's magnetism was neutralized, leaving the needle astatic. This done, the watch was substituted for the cork, the orientation of the balance wheel being the same as the small compass in the cork. This substitution of cork model, getting astatic position by bar magnet, and replacement of watch, was repeated for the four orientations, and the daily rate carefully determined. It was found to be sensibly constant in all positions.

The paper concludes with the following summary:

(1) Chronometers of precision are influenced by variations of the magnetic field in which they are placed to an amount depending on the degree of magnetization of the balance wheel and spr.ng.

(2) It is important to determine the magnetic moment of the balance wheel, mounted or not on the spiral.

(3) In observatories studying chronometer rates it is necessary to regularly determine the comparative variations in four rectangular azimuths for calculating the formulæ of correction.

(4) In all cases it should be the endeavor to attain an amplitude of 440 degrees for the oscillations of the balance wheel, as recommended by Phillips, to eliminate the action of the terrestrial magnetic couples.

(5) For precaution, in observatories as well as on board ship, it would be well to envelop each chronometer with a thick box of iron, so that the relative action of the terrestrial field may be lessened.—Nature.

A NEW PAGE-PRINTING TELEGRAPH.

By WILLIAM B. VANSIZE*

THE problem of automatically recording telegraph messages in Roman type is one that has fascinated inventors almost from the days of Morse. Royal E. House invented a type printing telegraph, which was in successful operation in this country in competition with the Morse and Bain systems prior to 1857. Many years ago the stock-ticker was perfected, and the Hughes, a tape printing telegraph, and several modifications of it have been employed for a long time with success by various telegraph administrations, chiefly on the continent of Europe. But it is only within the last year or two, almost at the close of the nineteenth century, that the problem of constructing a long-distance, high-speed, page-printing telegraph has been solved. A printing telegraph of this kind has recently come to my attention.

It has received the commendation of practical men in the telegraph service, and is believed to be of such simplicity and merit as to win for itself and maintain a position among the apparatus and instruments in constant use on commercial telegraph lines. The arrangement referred to has been devised and constructed by and under the direction of Donald Murray, an Australian journalist, without prior practical experience in telegraph work.

A RETROSPECT.

Looking back over the last thirty years, a substantial part of which time has been spent in the service of the large telegraph corporations, I can recall but comparatively few arrangements of apparatus which have passed the experimental stage and gone into commercial use. In 1869 there was the well-known Morse key and spaced alphabet, with the relay and sounder, and in some few instances the embossing register at way stations. In 1872 or 1873, circuits were equipped with balanced receiving apparatus and continuity preserving transmitters for duplex transmission. A little later, reversals of current were used for one set of signals and variations in current strength for another set of signals, affording two transmissions in the same direction. By duplexing this last named arrangement the quadruplex was brought to a more or less satisfactory condition through the efforts of Edison, Nicholson, Prescott, Gerrit Smith and others. About 1875 there was introduced on the lines of the Atlantic and Pacific Telegraph Company an automatic system of transmission improved by Little and Edison, employing a perforated paper strip at the transmitting station, and a chemically-prepared paper strip to record the Morse characters at the receiving station. Some years later the Wheatstone system was first employed by the Western Union Telegraph Company. Later Mr. Delany's arrangement for distributing a single main line between a number of sending and receiving operators at separated stations was employed on a special line between Boston and Providence. Numerous systems of printing telegraph, recording upon a strip of paper and upon a page have been patented and exploited by corporations organized for that purpose. The Phelps motor printer, in this country, and the Hughes printing telegraph upon the continent of Europe, both recording upon a strip, have had more or less extensive employment.

It is undoubtedly objectionable to use a perforating strip for transmitting purposes; but when to this is added a received record to be translated, there exist objections which only other merits, as in the case of the Wheatstone apparatus, partially compensate. At the other extreme is the simple Morse requiring no added time interval for translation at either end of the circuit; the operation of transmitting and recording being substantially co-extensive with the time in transit.

RECENT DEVELOPMENTS.

The later improvements in printing telegraphs have been directed to finding a substitute for the direct manual operation of the key-board and the employment of automatic transmission, like that of the Wheatstone system, by the use of perforated tape. The work of the operators in transmitting messages is thus first stored in the perforated tape, produced at any convenient speed, and the automatic transmission may take place at a high and uniform rate, the line and receiving instruments being worked to their full capacity. Another means for overcoming the delay due to direct manual transmission is to divide up the use of the line among several operators, a locking device holding the line for an interval at the service of each in turn. In this case while the speed of the operator may be slow, the total use of the line and instruments is greater than one operator could achieve working at his highest rate. There are two arrangements of apparatus now receiving attention employing the transmitting tape; that of Charles L. Buckingham, and that of Donald Murray, the latter here under consideration. The French system of Emile Baudot and the American system of Prof. Rowland employ an arrangement for dividing the use of the line among several operators.

What telegraph officials really need is the simplicity of the Morse system combined with increased speed of transmission and economy of time between the transmitting customer and his addressed correspondent. Up to the present time nothing has surpassed the Morse for this purpose. We may economize time on the wire by the Wheatstone, by the chemical automatic system referred to, or by the use of Delany's multiplex system; we can provide for a special class of telegraph business by adopting some of the high-speed transmitting systems like those contemplated by Prof. Crehore, or by Delany's modification of the chemical automatic. For these high-speed systems requiring preparation for transmission at one end and translation for delivery at the other end, a demand must be created by the requirements of a class of business to be transmitted and delivered faster than the mail, and somewhat slower than the transit time of the Morse system.

In the recent development of Morse there is an analogy between the contest between armor and armor-piercing projectiles on the one hand and the transmitter and receiver of the Morse code on the other. In the case of armored vessels an increase in the thickness or resistance of the armor has been answered by increased capacity for penetration by the projectile, and vice versa. In the early days the embossing or recording register could easily record the most rapid Morse sender. When receiving by sound it is an effort to keep up with the speed of a rapid sender, where the receiver uses pen to record in script. When the typewriter is substituted for the pen, the receiver can more than keep pace with the sender; if we introduce automatic Morse transmission we surpass the power of the human ear to receive and translate to the typewriter. If we transmit mechanically and record mechanically by means of a typewriter we shall have eliminated these human agencies with their limitations, and that is what Mr. Murray has done in a very complete and satisfactory manner.

Before further considering Murray's arrangement I want to assign due credit to my friend Charles L. Buckingham, who has a marvelously ingenious system in commercial use on the lines of the Western Union Telegraph Company. The received record is made in print on the ordinary telegraph blank; the transmission is by means of a perforated paper strip. It has a maximum capacity of about 100 words a minute on a circuit between New York and Chicago. The circuit can be duplexed to double the stated capacity. Its use, I believe, is successful, and commercially so.

MURRAY'S SYSTEM—TRANSMITTING ARRANGEMENT.

Mr. Murray employs a special alphabet, perforating the transmitting tape with a key-board perforator, having a separate movable lever for each character; each character occupies an unvarying linear space on the tape, and consists of five perforated and unperforated subdivisions of such space. The difference in the number and succession of these subdivisions or perforations imparts the designing characteristics. There are no spaces between successive letters or characters. Either makes and breaks, or reversals can be used in transmitting. It is to this fundamental fact—all letters of the same length—that the success of the system is due. Each letter occupies half an inch on the transmitting tape, and a similar length on the receiving tape. The result is that a comparatively simple transmitting tape perforator worked by an ordinary typewriter key-board is rendered possible; there is no necessity for employing a complicated differential paper feed mechanism to provide for letters of varying length. In connection with the ordinary typewriter key-board there is a group of ten punches, one punching magnet, and one spacing magnet, controlling a motor-driven escapement.

THE RECEIVING APPARATUS.

At the receiving station there is an electro-magnetic perforating device which accurately reproduces the transmitting tape by producing corresponding perforations and spaces. This received perforated tape passes from the receiving perforator into the typewriter operating device. This typewriter operating device consists of five longitudinally reciprocating bars or "combs," 39, Fig. 1, presenting five pointed terminals, 40, to a perforated plate or die, 38. The perforated tape passes between the surface of the perforated plate and the pointed terminals of the bars. The pointed terminals of these bars register respectively with the five holes in the die. The tape is moved along between the die and the pointed ends of the bars step by step, the length of a letter or character at each step, say one-half inch. When perforations in the tape coincide with the pointed ends of the bars and corresponding perforations in the plate and die, and the plate is moved toward the pointed ends of the bars, the bars are or may be separated into two groups; one group is moved longitudinally, corresponding with the unperforated subdivisions of the tape, the other group project through the perforations in the tape and in the die, and are unmoved. Lying over the five bars or "combs" at right angles thereto, are a series of thin metal strips, 41; each strip is mechanically connected with its individual key lever on the typewriter. The upper surface of the five bars first described are notched arbitrarily. These notches are caused to be aligned below any one of the strips under the control of the perforated tape and die; when any one of the strips drops into a groove a motor-driven cam engages it and produces a movement of the typewriter lever. The movement of the die and paper tape and of the typewriter key-lever is produced by motor-driven cams. It will be seen that this mechanism will operate not only a typewriter, but any key-board machine such as a typesetting machine or linotype. The perforated receiving tape is therefore available for setting type automatically.

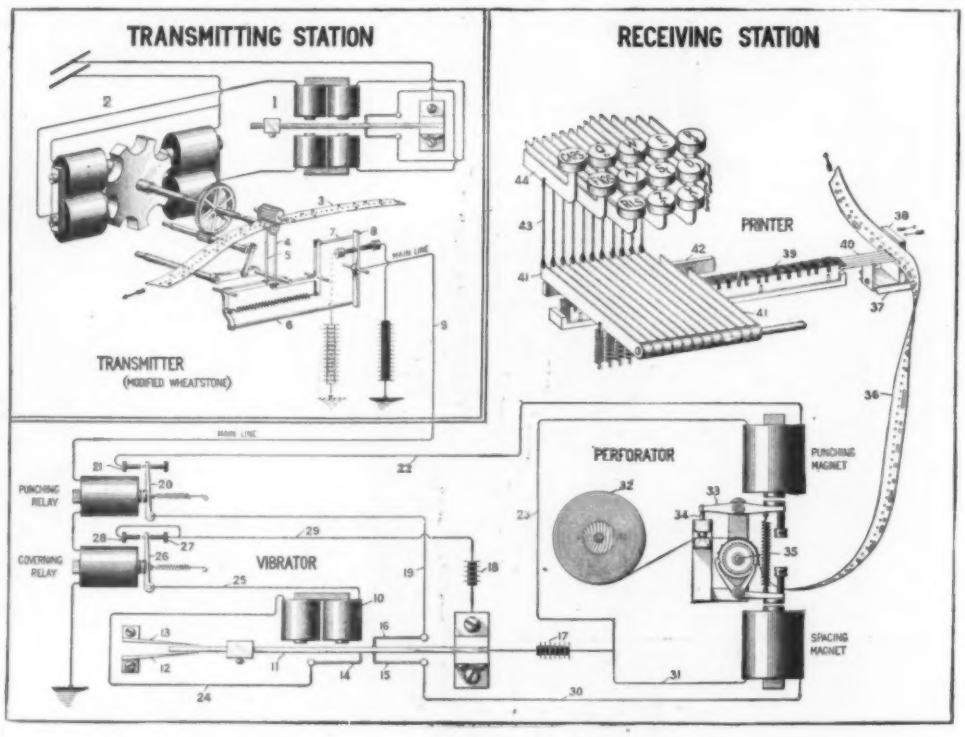


FIG. 1.

THE GENERAL DIAGRAM.

In the general diagram (Fig. 1) shown there is the apparatus at the transmitting station connected by a single main line, 9, with the apparatus at the receiving station. I have placed a double marginal line around the apparatus at the transmitting station to distinguish it. The vibrating reed, 1, is in a local circuit with an electro-magnetic motor, 2. The reed makes and breaks its own circuit, and is substantially like the well-known LaCour phonic wheel device. The "prickers," 4 and 5, familiar features in the Wheatstone transmitter are located as usual in line with the advancing lines of perforations in the transmitting tape, 3; 6 and 7 are reciprocating rods engaging respectively with opposite terminals of the centrally-pivoted pole changing switch arm, 8. The parts shown are all essential parts of the well-known Wheatstone transmitter, which is here used practically without alteration, except that the prickers, 4 and 5, are arranged to move or reciprocate together instead of alternately, thereby enabling any described multiple of a single impulse to be transmitted. The ordinary arrangement of the Wheatstone transmitter can only transmit unit signals or odd number multiples thereof;

* A paper presented at the 150th meeting of the American Institute of Electrical Engineers, January 25, 1900.—From the Journal of the Society.

it is practically an alternating current generator. The Wheatstone signals have to be built up by omitting a positive or negative impulse, hence an ordinary Wheatstone transmitter can transmit a dot or a dash equal to three or five dots, but cannot transmit a dash equal to two or four dots. Mr. Murray, to avoid this difficulty, arranges the prickers to reciprocate together instead of alternately. There is thus obtainable transmitted impulses or dashes equal to one, two, three, four, or five dots, with corresponding spaces.

In transmitting, the number of impulses thrown upon the main line is minimized by producing the impulses locally at the receiving station, and employing only sufficient main line impulses to determine the action of the perforator. At the receiving station there is, therefore, a main line relay to determine the action of the punching magnet, and a governing relay which operates to maintain unison between the main line impulses as they arrive and corresponding impulses in the local circuit. For the purpose of creating these local uniform impulses there is a vibrating reed, 11, operated by an electro-magnet, 10. The circuit of this magnet extends from the local battery, 18, through the reed, 11, contact point, 14, wire, 24, magnet, 10, wire, 25, armature, 26, of the governing relay, thence by way of the points, 27 or 28, and wire, 29, to the battery. The precise operation of the governing relay I will describe presently. The receiving perforator is composed of a punching magnet and a spacing magnet; the punching magnet operates a spring-retracted pivoted armature bar, 33, mechanically connected with the punch, 34, reciprocating through a guide block and engaging the tape, 32, upon the surface of a suitable die, over which the tape passes. The tape is fed along by a star wheel located on a motor-driven shaft, 35, and upon this shaft is an anchor escapement under control of the spacing magnet. The vibrating reed, 11, alternately makes and breaks the local circuit of the spacing magnet; this circuit extends from battery, 17, to the reed, 11, contact spring, 15, wire, 30, through the magnet and wire, 31, to the battery. The punching magnet is in a local circuit with a break point operated by the vibrating reed, 11, and controlled by break points of the punching relay, so that while the reed is continually generating local circuit impulses, these impulses are effective to operate the punching magnet at such times only as the punching relay is closed upon its front contact. This local circuit passes from the battery, 17, through reed, 11, to contact point, 16, thence by wire, 19, armature bar, 20, contact, 21, wire, 22, through the punching magnet, and wire, 23, to the battery. It will thus be seen that the reed, 11, is continually making and breaking two circuits alternately; first, that of the spacing magnet, which is a continuous operation; and second, that of the punching magnet, which is an intermittent operation, rendered so by the action of the punching relay. This punching relay and also the governing relay may be either neutral relays responsive to makes and breaks, or they may be polarized relays responsive to reversals of current. As the reed, 11, vibrates, the electric impulses in the spacing magnet circuit permit a steady progressive movement of the tape, 36. Upon the arrival of an impulse of current from the transmitting station, the contact points, 20 and 21, of the punching relay are held closed for one, two, three, four, or five times the time interval of one dot length, and while this relay circuit breaker is closed, the punch, 34, operates to perforate the tape as many times successively as permitted by the time length or duration of the transmitted impulse upon the main line. Mr. Murray has thus avoided the necessity of transmitting over the main line all impulses necessary to produce spacing, and all but a fractional part of the impulses necessary to produce the perforations. It is of vital importance, however, to preserve unison between the arriving transmitted impulses in the main line and the local punching and spacing impulses at the receiving station. This is done in the following manner:

HOW UNISON IS MAINTAINED.

The governing relay operates a circuit breaker, 26, moving between two fixed contacts, 27 and 28, electrically connected to the same circuit terminal, so that the moving contact in going from one to the other operates to open the circuit during its time of transit only. I have referred to this briefly as "armature transit time." This break in the local vibrator circuit takes place at the beginning and end of each main line signal, and as the main line signals arrive at a uniform rate and are of unit or multiple unit duration, the governing relay operates its break-point at uniform unit intervals or multiples of these intervals. In the same circuit in which this break-point operates, there is also the break-point, 14, of the motor magnet, 10, which works on the familiar buzzer principle. There are thus two break-points in the same circuit. If they open and close together, then full vibratory impulses flow through the motor magnet. If, on the other hand, the rate of vibration of the reed tends to accelerate, or the rate of the arriving current signals tends to lag, then the two breaks occur more or less alternately and consequently less current gets through—the impulses are clipped—and the rate of vibration of the reed is reduced. In practice, the receiving vibrator is set to go one or two per cent faster than the rate of the arriving signals, and then the governing action of the two interfering break-points in the same circuit results in the establishment of a steady dynamic balance between the accelerating tendency of the reed and the retarding tendency of the arriving main line signals. By this arrangement the necessity for sending correcting impulses over the main line to secure synchronism is avoided, the correcting impulses being obtained locally with the co-operation of the main line signals themselves.

It is to be understood that movable weights are present upon each reed, that of the transmitting station and that of the receiving station, and by varying the position of the weight upon the reed, the rate of vibration and the rate of transmission may be changed. At the receiving station there is provided means whereby the rate of vibration of the reed may be varied in harmony with variations in current in its motor magnet circuit. Under normal conditions with a motor magnet and circuit operated by break points carried by the reed, an increase of current, resulting in increased magnetic effort, will decrease the rate of vibration, and, conversely, a decrease of current resulting in decreased magnetic effort will accelerate the rate of vibration. This is believed to be due to eddy-currents generated by the magnetic field of force and the movement of the reed in such field. The action described, while it has a damping effect, is of no practical use as a means of regulation for the work to which the reed is here put, because of its exceedingly limited range. It is necessary in maintaining unison to have a considerable range of variation in the speed of this reed, such variation in speed to be attained in response to variation in the length of current impulses of uniform strength.

(To be continued.)

LIQUID FUEL.

THE subject of liquid fuel has again been discussed before the French Society of Civil Engineers with special reference to the establishment of supply stations for ships of war. Evidence exists of the increased use of liquid fuel in British vessels trading to the Far East, the installation of a charging station at Suez having been authorized by the Egyptian government, and for railway and other purposes in Russia, America and other countries. M. H. Guérin has contributed to the Génie Civil of May last an article on this subject, which is quoted in the last number of Science Abstracts. M. Guérin refers to previous articles in the Génie Civil, and to a paper in The Engineering and Mining Journal of New York by H. Tweddle which describes the best methods of using this fuel and of which M. Guérin's article is to some extent a résumé. The best results have been obtained by the use of crude petroleum.

The proportions of carbon, hydrogen, and oxygen in various hydrocarbons and their calorific power (in calories per kilogramme) are given in the following table:

	C.	H.	O.	Calorific power.
Light petroleum oil, American	86.894	13.107	—	10,913
Refined	85.491	14.216	0.293	11,047
Petroleum spirit	80.583	15.101	4.316	11,086
Crude petroleum	83.012	13.889	3.090	11,094
Light oil from Baku	86.700	12.944	—	10,843
Petroleum from the Caucasus	84.906	11.636	—	10,328
Ozokerite from Boryslaw	83.510	14.440	—	11,163

To realize the theoretical calorific power and the highest temperature of combustion it is necessary to supply to the combustible the exact quantity of air furnishing the necessary amount of oxygen, and to have the most intimate possible contact between the air and the fuel. Consequently gaseous fuel offers the best conditions for obtaining the best result, liquid fuel the next, and powdered solid fuel the next in order, although in practice excess of air, deposits of soot and other causes prevent more than a moiety of the useful effect being realized, especially in the case of coal firing. The methods of using fuel in the liquid form are, however, the most simple of all, and hence the repeated efforts toward a more general introduction of this kind of fuel.

Various forms of injectors or "pulverizers" which have been from time to time proposed and introduced are enumerated by the author, and the effects of different forms of jet on the completeness of the pulverization of the oil and its admixture with the air are discussed. The most suitable form of flame for a given furnace or process depends upon the quality of the oil and on the purpose to which the heat of combustion is to be applied.

Tweddle has found by experiment that in order to obtain the highest possible temperature from liquid fuel it is necessary to burn it in fire-brick combustion chambers of limited capacity, and that for evaporative effects an injector worked by steam is preferable to one using an air-jet which is more suitable for reheating, forge, and other furnaces of that class. The author introduced the use of petroleum fuel on the Oroya Railway in Peru in the year 1890, where experiments had to be conducted under unfavorable conditions. Starting from sea-level at Callao the railway crosses the Andes at an altitude of 4,250 meters, with a total length of about 160 kilometers. The gradients and curves are consequently against the realization of a high duty. Nevertheless, the consumption of oil was but little over half that of coal although the calorific power of the oil as compared with that of the coal was only as 1.4 is to 1.

The apparatus used on this railway is described in detail with illustrations of the burner, or pulverizer, and of the type of furnace employed.

The evaporative effect produced by firing boilers with American petroleum was in 1896 found by the Weyher and Richemund Company to be 12.5 pounds of water per pound of fuel; at the power station of the electric tramways of Los Angeles it was 12.89 pounds; and in some other experiments, with Borneo petroleum, 758 grammes of oil produced the same results per horse power hour as 1,030 grammes of Newcastle coal. At the last exhibition in Chicago the steam boilers, working at about 125 pounds per square inch pressure of steam, gave with mineral oil fuel an evaporation of 14.25 pounds of water per pound of combustible as against 7 pounds per pound of coal. The theoretical evaporative power of carbon burning to carbon dioxide is 15 pounds of water at boiling point under atmospheric pressure.

In steamships it is necessary to use heavy oils igniting at 121 deg. to 149 deg. C., in order to guard against the risk of fire, these oils being quite safe even if a bar of red-hot iron be plunged into them. Experiments made by the French government on the use of petroleum in torpedo boats proved that it is too dangerous for use in such vessels.

Tweddle made experiments by firing cannon-balls and shells into a pile of casks containing benzine, with the result that the flame from the exploding shell frequently set fire to the benzine vapor. Practically the same effects were produced with kerosene and crude petroleum, but with oil igniting at 115 deg. C. no flame was produced even under much more severe tests. If the oil employed has a sufficiently high point of ignition it offers greater security from fire than coal, and much more than powdered fuel in bulk, both under the conditions of warfare and under ordinary conditions in which spontaneous combustion sometimes occurs.

The handling and storage of liquid fuel are also a much more easy matter than is the case with coal; the necessary appliances are fewer and more simple, and the minimum of labor is all that is required. There are also other minor advantages, not the least of which is the saving of space on board ship for storage of fuel.

In furnaces used in the industrial arts some of its advantages may be realized, where a high temperature and a pure flame are desired, and when the price of coal is high. The author gives some illustrations of such furnaces, and, in particular, of one designed by Tweddle for the combustion of benzine.—Journal of the Society of Arts.

SHRINKAGE OF THE NICARAGUA CANAL.

To the Editor of the SCIENTIFIC AMERICAN:

IN the SCIENTIFIC AMERICAN SUPPLEMENT for May 14, 1900, Prof. Angelo Heilprin assumed to show from the observations published by the Nicaragua Canal Commission that Lake Nicaragua has declined 20 feet 9 inches in level within the last nineteen years. To do so he employed two assumptions, one of the inflow to Lake Nicaragua based on the old Rivas rainfall record, and the other on the outflow from the lake. Any one understanding anything of hydraulics knows that any assumption of inflow based on a single rainfall record is exceedingly uncertain, and the assumption of the outflow from Lake Nicaragua is absolutely without basis whatever. Prof. Heilprin pretends to base it upon the outflow measured in 1898, but such a basis is impossible, as there is no known relation between the outflow of 1898 and that for former years. It is often the case that lakes like Lake Nicaragua have a large discharge in one year and none at all in another. This is often the case with Lake Managua, which drains into Lake Nicaragua, and the absurd conclusions to which these assumptions lead Prof. Heilprin are ample evidence that they are wide of the mark. The unwarranted claim which the professor makes that these assumptions are based on any report of the Nicaragua Canal Commission is very hard to reconcile with intellectual honesty. The absurdity of his conclusion was pointed out by me in The Geographic Magazine of September, 1900. In the SCIENTIFIC AMERICAN SUPPLEMENT for January 12 the professor rejoins in an article of nearly two columns, which is really nothing but a reiteration of his previous statement summed up as follows:

"Manifestly, then, the data furnished by the Hydrographer of the Nicaragua Canal Commission are entirely erroneous, or they lead incontestably to the conclusion that Lake Nicaragua is undergoing a steady and progressive abasement of its surface level."

Lake Nicaragua is not perceptibly undergoing a steady and progressive abasement of its surface level. If this fact leads the professor to the opinion that the hydrographic data are entirely erroneous, we may rest content in the belief that this is not the opinion of the Commissioners under whose authority they were taken, of the assistants who took the observations, or any one else who knows anything about them. The point of chief concern, however, is that the real facts be laid before the readers of the SCIENTIFIC AMERICAN who have seen Prof. Heilprin's gratuitous statement of the shrinkage of Lake Nicaragua.

The following letter on this point from Hon. William L. Merry, United States Minister to Costa Rica and Nicaragua, is parole evidence of the truth of my contention that Lake Nicaragua has not perceptibly shrunk within a generation or more:

SAN JOSE, COSTA RICA, October 21, 1900.

Rear-Admiral JOHN G. WALKER,
United States Isthmian Canal Commission.

My Dear Sir: You have certainly read the article in The Geographic Magazine by A. P. Davis, in relation to the water of Lake Nicaragua, which Prof. Heilprin says is drying up. I took charge of the Nicaragua transit for the Central American Transit Company in 1865. When twice passing over the lake and river San Juan this year, I carefully noted the condition of the river and lake, and can confidently assert that the river has not changed since 1865 above the Colorado junction, where the lower San Juan is somewhat worse, owing to the increased diversion of water to the Colorado. . . .

Your friend and obedient servant,
WILLIAM LAWRENCE MERRY.

Whole volumes of such testimony might be collected if there were any use of it. But it is idle to dwell upon this point, on account of the absurdity of Prof. Heilprin's position, which is manifest to any one who has ever seen the San Juan River or Lake Nicaragua.

If Prof. Heilprin's theory is correct, all the old Spanish fortifications at Granada, the wharf, warehouses, a part of the city, the wharves and warehouses at San Jorge and San Carlos, as well as several villages and hamlets, around the lake, must have all been constructed under water, since they are less than 20 feet above the lake level. It would be easy to point out numerous other absurdities involved in Prof. Heilprin's ridiculous assumption.

In no report issued under the authority of the Nicaragua Canal Commission or of the undersigned, is there any statement of the actual or probable, observed or assumed, continuous outflow of Lake Nicaragua prior to 1898. As the assumed outflow is an essential part of Prof. Heilprin's argument, his statement that it is based upon the data furnished by the Hydrographer of the Nicaragua Commission is absolutely false.

ARTHUR P. DAVIS,
Hydrographer Isthmian Canal Commission.
Washington, D. C., January 21, 1901.

THE COLWELL ROTARY ENGINE, RECIPROCATING ENGINE AND CONDENSER.

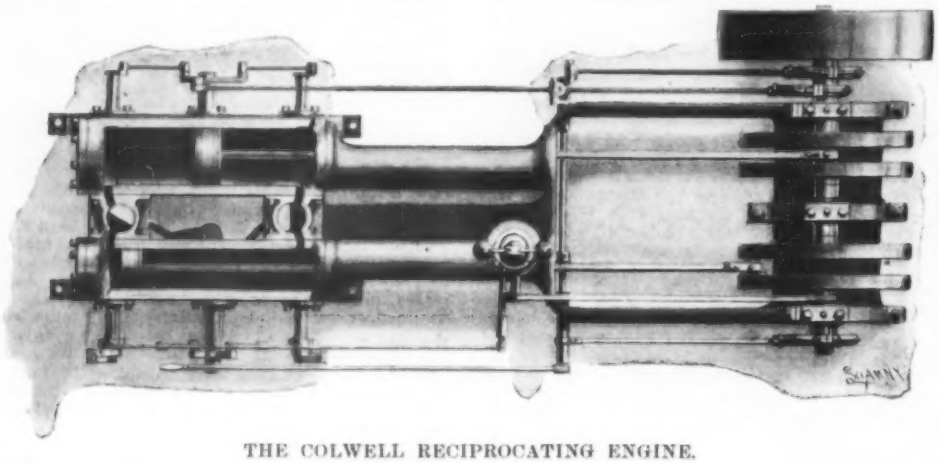
THE many failures which have attended the efforts to produce a successful rotary engine have led many into the erroneous belief that there is something inherently wrong in the principle of the rotary engine—that, like perpetual motion, its theory is based upon a misconception or absolute ignorance of natural physical laws. As a matter of fact, however, the objects aimed at in the rotary engine are perfectly legitimate, and the principles upon which inventors have been working ever since Ramelli, in 1588, designed his rotary pump, of which the rotary engine is actually a reversal, are perfectly sound.

The stumbling blocks which have brought rotary engine builders to grief have been entirely of a mechanical or structural nature.

Undoubtedly the feature that has proved most attractive in the rotary engine is the fact that the pressure on the piston is at all points of the stroke applied tangentially to the circle described by the crank, and so avoids the "dead centers" of the reciprocating engine. The turning moment of any given amount of pressure at the crank pin upon the crank shaft is the product of this pressure by the vertical distance between the direction in which it is exerted and the axis of the crank shaft. In a reciprocating engine this vertical distance varies from zero on the dead centers to a maximum just before the half stroke, when the crank and connecting rod are at right angles. Consequently, a constant and even turning moment can be secured in the reciprocating engine only by connecting two cylinders to a common shaft and placing the cranks at ninety degrees. The piston pressure of a rotary engine, on the contrary, is always exerted tangentially to the circle described by the crank, and, consequently, its turning moment is at a maximum throughout the whole revolution.

Chief among the difficulties which have hitherto stood in the way of the production of the successful rotary engine have been those of providing a satisfactory form of valve gear, steam ports, etc., for the admission and control of the steam and a suitable sliding abutment to support the reaction of the steam within the cylinder. The accompanying engravings of a rotary engine, which have been prepared from drawings furnished by Mr. W. S. Colwell, of the Cosmopolitan Power Company, of The Temple, La Salle and Monroe Streets, Chicago, Ill., show an ingenious attempt on the part of the designer to overcome these difficulties, and it will be noticed that both in the details and general plan of the engine, there is a departure from previous types.

The vital feature of the engine is the abutment



THE COLWELL RECIPROCATING ENGINE.

mechanism, shown in the accompanying detail drawings. A rotary engine to be efficient must be so constructed that the piston shall be under pressure substantially throughout its entire stroke, and it must be capable of expanding the steam to the extent that is attained in engines of the reciprocating type. To secure these results the steam must be admitted with a minimum amount of clearance between an abutment and a movable piston, and the supply must be capable of being cut off at any desired point of the revolution. Also it is evident that for the best results the arc of the circle through which the steam pressure is operative on the piston must be the greatest possible. This requires that the abutment be allowed to remain in place until the piston is about to complete the entire circle of movement, then very rapidly withdrawn to let the piston pass, and as rapidly re-inserted behind the piston so that the steam may be again admitted before the piston has had time to travel any appreciable distance without pressure.

Inventors have either attempted to move the abutment by rapidly-acting cams or tappets, and thus attain the desired rapidity of movement, but at the expense of great clash and concussion, and the attendant destruction of parts; or they have employed gradually-acting cams, which possess the other fault of being too slow and requiring the steam to be exhausted and the abutment started while the piston has still a long stretch to travel and the expansive force of the steam is yet unexpended.

In the engine illustrated the abutment is withdrawn by a reciprocating member which is locked into operative connection with the abutment at the extremity of its stroke, where it is, of course, at rest, no matter what its reciprocating speed may be. This reciprocating member is so controlled that the abutment is opened at the proper time by a modified form of the old and well-tried locomotive link mechanism, thus causing the time of opening of the abutment to vary when the engine is reversed.

The operation of the valves and abutment is shown clearly in the detail views. The abutment is withdrawn only just in time to clear the front face of the piston as it passes forward in its path. When the engine is reversed, the lower admission valve and the upper exhaust valve are utilized. The right hand drawing shows the mechanism for swinging the abutment, which is made exceptionally light and is pivoted on a vertical shaft which is attached by a rocker arm and connecting rod to an oscillating disk, as shown. The disk is oscillated by a horizontal shaft which is attached to a rocker arm actuated by the valve gear link motion. As this arm reciprocates it engages a pin on the disk and draws it forward, thereby swiftly removing the abutment from the steam space. The instant the abutment is clear of the cylinder, the horizontal arm is tripped and the disk under the influence of the dash-pot, which is shown below the disk, flies back to its normal position and swings the abutment into place within the cylinder. The arrangement and action of the valves and abutment indicate a careful study of the idiosyncrasies of the rotary engine.

The reversing of the engine is accomplished by the movement of a single hand lever, just as in any other steam engine, which simultaneously resets the inlet and exhaust valves and changes the position of the link. In order to accomplish this, however, it has been necessary to devise a valve-gear by which the cut-off is regulated by a modified form of the usual governor, as shown.

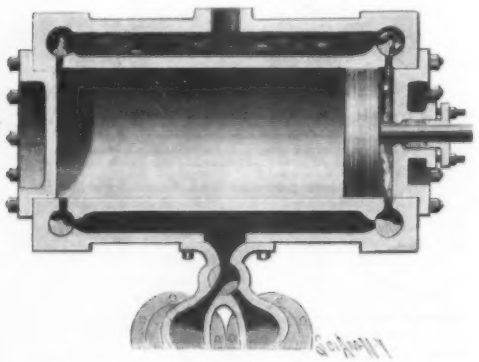
Another valuable feature is the device for subjecting the steam cylinder on the exhaust side of the piston to the action of a perpetual vacuum. Much labor and effort have been spent in endeavoring to condense the exhaust of a steam engine and thus keep up this vacuum action while saving the water of condensation, but experience has demonstrated that the frequent failure of the condenser to do its work and the consequent back pressure on the engine more than offset any good to be gained.

In the system employed by Mr. Colwell, as will be observed in one of the illustrations, a vacuum is produced by the condensation of the steam with a fine spray of water forced into the receiver by a small pump, which also takes the condensed water from the bottom of the receiver and feeds it through the hot well into the boiler. The exhaust is first opened to the atmosphere to let the bulk of the steam escape and the engine cylinder is then automatically connected through the same exhaust valve with this vacuum which exerts a material propelling force upon the piston. With this method it is obvious that as soon as the steam is exhausted and the piston passes the abutment, the advance side of the piston may be again subjected to the vacuum, and this assisted by the latter from its very start and up to the point in its stroke where it reaches the exhaust port. The bulk of the steam being then exhausted and the piston having again passed beyond the abutment, the exhaust valve is automatically reset to connect the cylinder with the vacuum.

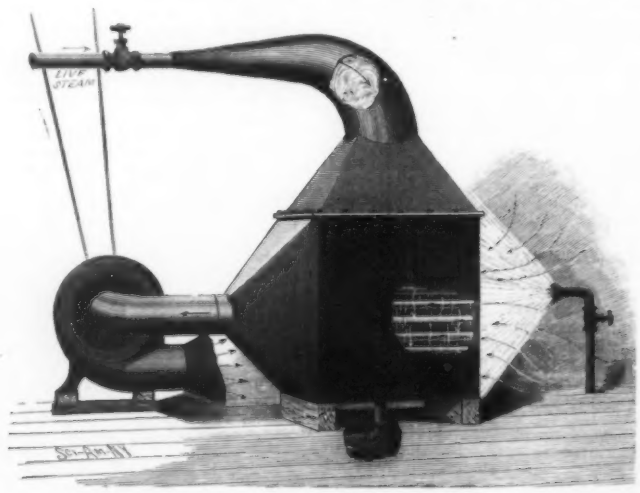
Besides the rotary engine described the inventor, Mr. W. S. Colwell, has also patented an engine in which it has been his purpose to embody the good qualities of the rotary engine in a reciprocating engine. One of the most salient defects of the reciprocating engine, as we have already remarked, is its liability to slack or stop on the dead centers and the gradually decreasing leverage of its crank as it turns toward such centers. The first of these evils the inventor has endeavored entirely to remedy, and the effect of the second it has been his aim to neutralize. In carrying out his intention and attaining these results he employs two cylinders—a primary cylinder and a secondary cylinder. Steam is transferred from the primary into the secondary, and the pistons are connected respectively to two cranks set on the same shaft at 45 degrees apart. At first glance this appears to be the ordinary compound engine, but upon further inspection the contrary clearly appears. In this engine the pressure is admitted to the primary cylinder, and after the piston therein has made a part of its stroke, communication is opened at the same end between the primary and the secondary and a part of the same steam is admitted to the secondary. At this period the primary piston has made a half stroke and the secondary piston is just beginning its stroke and moving in the same direction. Hence it is seen that the same ingulf of steam works both pistons forward or in the same direction, and by the time the primary piston reaches the limit of its stroke and its crank is on dead center the secondary piston will be only half way and its crank will be at the point of its greatest efficiency of leverage and therefore propels the shaft a full quarter turn further, while the primary crank is passing around its dead center and the primary piston is taking steam and getting under way on its return stroke. Thus one ingulf of steam produces three-fourths of a revolution, very much as in a rotary engine. When the secondary piston reaches the end of its stroke, the steam is exhausted and the operation is repeated on the return stroke. Our larger illustration shows the relative position of the two pistons and the smaller one the inlets and outlets, together with the piston of one of the cylinders. This engine operates in connection with the vacuum the same as the rotary type.

Steam has been condensed in various ways. Sometimes cold water is directly injected into the steam to be condensed; or the steam is brought into contact with one side of a surface, on the other side of which cold water or air impinges; or the steam is condensed by a surface on whose other side is performed some method of rapid evaporation, such, for example, as the evaporation of water by the heat of the steam to be condensed, usually aided by an inducted current of air. Whether the cooling agent be water or air, the result is produced only at the expense of an amount of the cooling agent vastly disproportionate to the amount of water of condensation obtained; and where cooling by evaporation is relied on, it is, of course, necessary, theoretically, to evaporate at least a pound of water on the outside of the surface separating the water and steam, for every pound existing on the other side in the form of steam. In practice it requires a much greater percentage, although the evaporating process may be accelerated somewhat by rarefying the air. In order to succeed, therefore, with the devices it has always been necessary to employ very extensive condensing surfaces and comparatively large volumes of the cooling agent or medium.

An improvement over these forms has been invented



SECTIONAL VIEW OF CYLINDER OF RECIPROCATING ENGINE.



THE COLWELL CONDENSER.

and patented by Mr. T. M. Colwell, which is designed to increase the efficiency of the steam condenser. The apparatus illustrated has been used for the last two years and consists of a sheet metal box, which, if desired, might be made of ordinary tin 3 feet wide, 29 inches long and 2 feet 11 inches high, into which the steam was admitted from a 25 horse power boiler running at its full capacity. This metallic box is pierced by 435 tubes made of tin 29 inches long and 15-16 of an inch inside diameter. These tubes at one end open directly to the atmosphere and at the other end or side of the box their ends are capped by a hood to which is connected a 1 horse power exhaust-fan which draws air through these tubes. At the side of the box where the tubes open to the atmosphere is arranged a very fine spray, much finer than anything heretofore suggested in a condenser. This spray throws only about 100 ounces of water per hour. Only a small percentage of that amount passes into the tubes, and the exhaust-fan draws about 80,000 cubic feet of air per hour. This apparatus, receiving steam at full blast from the 25 horse power boiler, condensed into water all the steam that the boiler produced, and by actual test, weighing the water produced every five minutes for one hour, yielded 792 pounds of water of condensation, which, divided by 30, the number of pounds per hour which must be evaporated to produce 1 horse power, gives 26.4 horse power, which shows that the boiler at that time had a greater capacity than its estimated horse power.

A thermometer placed in the enlarged pipe above the air pipes indicated a temperature of 210 deg. F. Another in the pipe conveying off the condensed water showed 160 deg. F. A thermometer placed in front of the blower stood at 145 deg. F., while one placed in the air discharged noted 144 deg. F., one degree lower.

In a test made on January 8, 1901, the weight of water condensed was measured every five minutes for two hours; the following are the details:

First Hour.

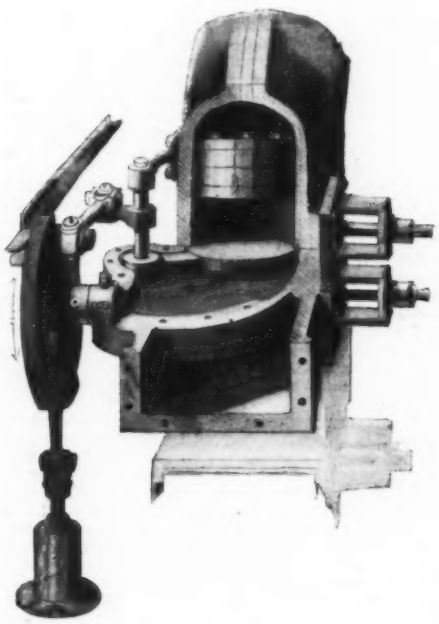
Test.	Pounds.
1	66
2	65
3	65
4	65
5	66
6	66
7	66
8	66
9	66
10	66
11	66
12	66
	789

Second Hour.

Test.	Pounds.
1	66
2	66
3	66
4	67
5	67
6	67
7	66
8	67
9	67
10	67
11	67
12	67
	800

The foregoing tests indicate quite clearly the practical economy of this form of condenser.

We are advised that the rotary and reciprocating engines as well as the vacuum condenser and steam condenser have been in actual use for some time and their efficiency has been thoroughly demonstrated.



ABUTMENT OF THE COLWELL ROTARY ENGINE.

SAKHALIN COAL.

COAL was first discovered on the island of Sakhalin, off the coast of Siberia, as long ago as 1787, and has been worked since 1852, but the production was very small until recently. Two coal basins are now worked, according to a recent note by F. F. Kleye, in the Oesterreichische Zeitschrift fuer Berg und Huettenwesen. In 1899 the output from the Due Basin was 1,500,000 poods (24,570 metric tons), and from the Mgatsch Basin 800,000 poods (13,104 metric tons). Coal outcrops have been found at other points, but are not worked at present, as they are at points not easy of access from the coast.

The coal from the Due Basin differs from that obtained at Mgatsch. It is looked upon as the best variety, for forge and factory purposes, found in the East; the calorific power of the air-dry coal is 8,249 calories, and the yield of coke equals 65 per cent. For marine boilers it is considered too small and too smoky. It is friable and will not stand much handling. Mgatsch coal is harder, and can be raised in larger lumps, and gives only a light, gray smoke. For ship use it was tested in the Russian Pacific fleet and found a good steam raiser, the flame being regular and not too long, and the consumption about 20 per cent less than Due coal or Takasima (Japan) coal. Unlike the latter it does not corrode the firebrick linings of boiler furnaces. The tests further showed a calorific power of 7,174 calories, 87.9 per cent of combustible matter, 10.2 per cent of ash, and 1.8 per cent of moisture. The ratio of consumption, compared with Cardiff steam coal, was ascertained to be as 13 to 10.

As the result of attempts to improve the character of Due coal by judicious admixture of Mgatsch coal, the two producing companies have agreed to pool their output, it being found that the Mgatsch coal checks the tendency of the other to break u while that property enables even the smallest particles of Mgatsch coal to be properly utilized; the steam-raising power of the mixture greatly exceeds that of either used alone, and the tendency to smoke is reduced. Five grades are prepared for market—unmixed Due coals for forge, factory and steamer use; unscreened Mgatsch coal for steamers; screened Mgatsch, which makes an excellent steam coal for marine work; Mgatsch smalls, and mixed Mgatsch and Due coals, unrivaled in the Pacific for ships' use.

The demand for these grades is very brisk in the Amoor District, and shipments are made to Vladivostock, Port Korrakovsky, Petropavlovsk, Port Arthur, etc., the supply being less than the demand. The supply could be very largely increased if additional capital was put in the mines and if more labor could be obtained.—Engineering and Mining Journal.

A USEFUL ZINC ALLOY.

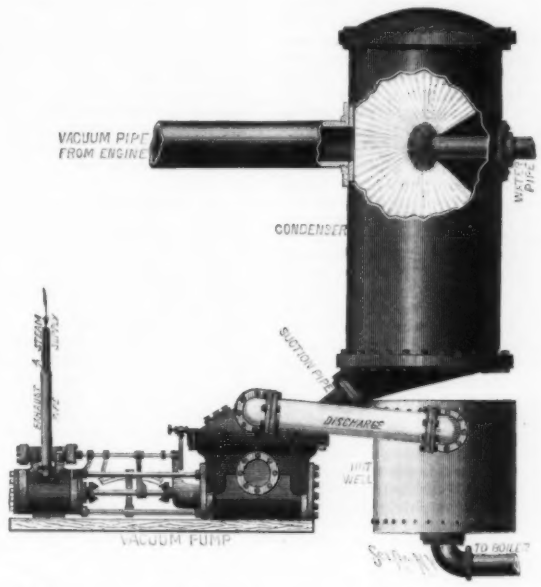
By WALTER J. MAY.

IN foundries and other places where it is desirable to have an easily melted metal of fair strength for patterns and the like, the writer has found the following very good, as not only is it fairly hard, but it tools well, and does not get so knocked about as white metals in which lead forms the base. It also makes a decent filling for iron castings which are faulty, and on planed surfaces works very well indeed, not often wearing away. Of course the alloy is not at all new, nor is there any invention in it, but those who have not tried it may find it useful. After being made, the alloy can be melted as readily as plumbers' wiping metal, and it can be cast in either sand or plaster moulds as readily as brass or any soft metal.

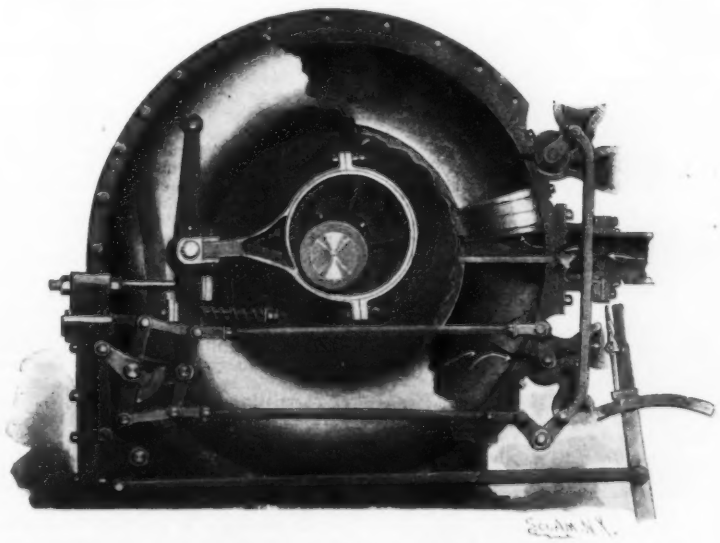
The proportions are 88 pounds zinc, 10 pounds copper and 2 pounds aluminium, or the aluminium can be omitted and its weight in copper added, a somewhat harder alloy then being obtained.

The copper is melted in a small pot, and enough dry zinc added to kill it and prevent its spitting when added to the bulk of the zinc. Meanwhile, the bulk of the zinc is melted separately, and when ready the killed copper is poured in and well stirred. When thoroughly fluid the aluminium is added, and after well stirring the alloy is poured into flat plates about an inch thick. As soon as set, these plates should be broken up and remelted under small charcoal, and then poured into inch bars in covered sand moulds, the bars being cast horizontally. When cold the alloy will have a surface very like oxidized silver, and will file and polish perfectly smooth, with a cut to the file like soft cast iron.

Cast in sand moulds like brass, using a very fine facing sand, ornamental castings come out like oxidized silver if allowed to become cold in the moulds. This does not last long, however, unless the castings are lacquered with clear lacquer, or resin varnish, but a very slight protection keeps the brightness for years.



VACUUM APPARATUS USED IN CONNECTION WITH COLWELL ENGINES.



SECTIONAL ELEVATION OF ENGINE, SHOWING VALVE GEAR, PISTON, AND ABUTMENT.

A NOTE UPON ENAMELS.

By CHARLES S. TOMES, M.A., F.R.S.

IT has long been known that if it is desired that enamels shall be brilliant and transparent, it is essential to wash the enamel after it has been reduced to fine powder, prior to its application to the work, rejecting the lighter portions, which eventually settle from the washing water as a fine mud, and that the coarser the powder the more brilliant the fused enamel will be. But, although the fact is known empirically, its rationale is not well understood, and, indeed, I cannot find that it has ever been carefully investigated, although more or less unsatisfactory explanations have been offered. With a view to ascertaining what really happens I lately undertook a short series of experiments, which seem to throw light upon the question. I first took an ordinary transparent flux, of fairly high fusing point, and applied portions of this after powdering in an agate mortar to a piece of gold, one portion being unwashed, and the other thoroughly washed. The former, the unwashed, fused into a very cloudy film, which, on microscopic examination, was found to owe its opacity entirely to an infinite number of very minute round air bubbles; no solid opaque particles could be found in it, nor was the matrix between the bubbles at all opalescent. The washed sample yielded a perfectly transparent, colorless film, which on being examined was found to contain but few air bubbles, and these of large size. It therefore appears that the dirty cloudy look of an unwashed enamel is due to the dissemination all through it of exceedingly small bubbles, and not to any opacity in the material itself; this agrees with the statement made to me by a very experienced worker in enamels that an unwashed enamel, or the rejected mud from washed enamel, always yields what he termed a "rotten" coating. Several experiments having given precisely the same result it remained to discover the cause of the bubbles. In Mr. Cunynghame's valuable "Art Enameling Upon Metals," 1899, it is suggested that "The reason why the mud becomes opaque when fused upon the metal is, I think, that a portion of the coloring matter is separated, and that the enamel becomes partly decomposed by the action of carbonic acid upon the alkali which it contains. The carbonates of soda or potash thus formed become, on heating, again decomposed by the silica, and minute bubbles of carbonic acid gas are formed."

This explanation from a chemical point of view did not appear to me probable, and it admitted of being readily tested in several different ways. A small portion of very cloudy enamel was rapidly crushed in a few drops of distilled water, passed through a tiny filter, and the filtrate produced no precipitate with lime-water. It was, therefore, pretty certain that the bubbles did not contain free carbonic acid gas. A portion of transparent enamel was powdered, dried and weighed in a very sensitive balance; it was then rubbed up with distilled water for some time and left in the water for four hours; it was then repeatedly washed, being allowed time to settle before pouring off the washing water. After being again dried its weight was found to be unchanged, with the exception of a very trivial loss, accounted for by the opalescence of the first washings.

A further portion was weighed after being coarsely powdered, then rubbed down into very fine powder and thoroughly washed. The residue was thrown upon a weighed filter, washed and dried, and then again weighed. The washings, which had they been allowed to settle would have deposited "mud," were also passed through a weighed filter, dried and weighed again. The sum of the two weights amounted to just that of the original powder with the exception of a very small loss, which was anticipated, as the filtrate after repeated filtration remained slightly opalescent. It is astonishing to find that when a glass is powdered even coarsely some part of it passes almost at once into a powder of such extreme fineness that it passes through a filter, and the longer the powdering is continued the more of this exceedingly fine powder is formed. It is this which is got rid of by washing, and it is this which by its presence causes opacity in the fused enamel.

But it is hardly conceivable that any chemical change can have taken place without alteration of weight; if carbonic acid were taken up, as suggested by Mr. Cunynghame, there would be an increase of weight, while if any soluble material were removed there would be loss. And microscopic examination of the coarser portions and of the mud reveals no difference in the particles except in their size; each alike consists wholly of angular transparent particles. A further portion of powdered enamel was digested for some hours in a saturated aqueous solution of carbonic acid, and on drying and weighing was found to have undergone no change in weight.

In all these cases the filtrates, after being left for some days to settle, so as to get rid of the slight opalescence, and then decanted, yielded no residue on evaporation. It may, therefore, be concluded that no chemical change takes place, but that the inclusion of air in the ultimate fused enamel, when this is opaque, is due to mechanical causes only. Probably what happens is that the very fine particles, especially on the surface, become very thickly agglutinated by the heat of the furnace, entangling between and beneath them an infinity of fine bubbles; but that when coarser particles are fired they run together more slowly, and then the air escapes for the most part, the little which remains forming large bubbles which do not practically interfere with the transparency. No transparent specimen of enamel fused on metal which I have examined was ever quite free from bubbles, while the opaque specimens were virtually consolidated froth.

In one instance only did I meet with a different result. In this case the enamel was an opaque white of very low fusing point. If this was kept, after being powdered, under water for a few days it was found to have gained weight on being dried, and when fired it swelled up and frothed to such an extent as to be absolutely useless, behaving just as a crystal of borax does when heated. A portion of this powdered, steeped in water for two days, dried at 100 deg. C., and then heated into redness in a hard glass-tube gave off water as it frothed up. In this case therefore it was evident that the fused mass as sold contained some salts which were anhydrous, but which were capable of becoming hydrated by soaking in water. It is a common practice to add borax to a glass in order to lower its fusing point, and it seems probable that this sample contained a large amount of borax or of some borate capable of taking up water of hydration.

But this I have met with only in this one sample; no other has shown any change by being kept under water. Enamels of various colors have been experimented upon, but with no difference of result.

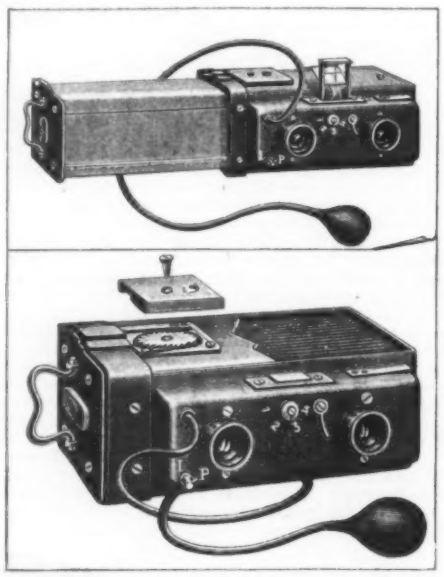
The above experiments appear to prove that water, at all events in short periods of time, exercises no chemical influence upon the enamels; hence, if there really be any advantage in employing a non aqueous fluid, such as paraffin, during the powdering process, as has been suggested as an improvement, the benefit must be due to causes other than those supposed by its advocates.

When, however, an enamel reduced to impalpable powder is used in a sufficiently thin layer, most of the air is able to escape before the surface glazes, and so a fairly transparent film is obtained.—Journal of the Society of Arts.

THE POCKET STEREOSCOPIC APPARATUS.

SINCE magazine apparatus have been made, the method employed for causing the plate that has been exposed to pass beneath the package of other plates has been modified in various ways, and it appears that all the combinations that permit of reaching such a result have been exhausted.

The system that has met with the greatest success is the Hanau frame, which has been applied to the most widely used models of twin-lens cameras. It may be said that it is universally known. With this kind of magazine, the plate to be changed remains in place when the drawer that contains all the others is pulled out. It then falls to the bottom of the free space left by the drawer, and, when the latter is shoved back, is situated underneath. As it is always



THE "MARSOUIN," A POCKET STEREOSCOPIC APPARATUS.

the top plate that is to receive the impression, the height of the magazine is added to that of the camera, which is proportionate to the focus of the objective. Since the magazines for 12 or 18 plates are always about 2.4 inches in thickness, and since the objectives generally have a focus of from 3 to 4 inches, it results that the minimum dimensions in height that can be given a twin-lens camera is about 5.5 inches.

M. Hanau, by but very slightly modifying his frame, has recently discovered a means of reducing such height in notable proportions, and in a very simple manner. As a camera, he utilizes the space left by the drawer when the latter is pulled out. The plate above, falling to the bottom of this space, is held there by two springs, and is exposed while the drawer is open. This mode of operating offers the advantage of permitting of a reduction of the height of the apparatus to a degree equal to the thickness of the magazine. Besides, there are few chances that two exposures will ever be made of the same plate, since the operator cannot fail to see that the drawer is open and will always think to close it immediately after freeing the shutter.

This principle is evidently applicable to apparatus of all dimensions; but the inventor, in order to show its advantages, has in the first place seen fit to construct a stereoscopic model for 1.8×0.04 inch plates which he call "Le Marsouin," and in which the camera is completely suppressed and replaced by the magazine which is for 18 plates. The objectives are mounted upon a forepart which is 0.6 of an inch in thickness and contains the shutter, the change of speed and all the parts relating to exposure and instantaneousness. This forepart varies with the objectives employed. When it is removed (and it can be removed very easily, since it is mounted in a slide like the board of an ordinary objective), we have a box 5.5 inches in length and 2 upon all the other sides. The upper part, that which corresponds to the top sensitized plate, is masked by a shutter, which opens when the apparatus is maneuvered, a metallic partition falling automatically in order to limit the two images.

The entire apparatus is of aluminium, and weighs but about fifteen ounces. At every movement of the drawer a counter automatically inscribes the number of plates exposed.

This apparatus, we think, is the lightest and smallest stereoscopic camera known. The manufacturer will doubtless ere long apply the same principle to apparatus of larger size, always with the result of diminishing the bulk to a degree equal to the thickness of the magazine.—La Nature.

BORSIG ELECTRIC PLOW.

THE A. Borsig Company, of Berlin, one of Germany's large manufacturing concerns of steam and electrical machinery, has introduced an electrical plowing system which seems to have met with favor, especially among the large-estate owners of Germany and the beet-sugar producers, says The Western Electrician. Germany, as is well known, is the greatest beet-root sugar-producing country in the world. Most of the great sugar-mill proprietors own at the same time extensive estates on which they cultivate their own beet roots, and the Borsig company is especially pushing its trade in electric plows among the sugar mills in Germany, Austria-Hungary and Russia. Agencies have been established in all the principal sugar-producing centers of these countries.

The cost of such an electrical plowing outfit for an average sugar-mill estate is given by the Borsig company as $44,250. A steam engine of 250 horse power is needed to operate five electric plows. This engine may be worked condensing before and after the season, but during the season the exhaust steam may well be used in the evaporating apparatus. The estimated items of cost are as follows:

Engine	$7,500
Electric generating station	5,000
Line construction and transformers	10,000
Five electric plows and sundries	21,250
Miscellaneous	500
Total	$44,250

At this cost the capital to be invested amounts to about $8,850 per plow, thus being about 40 per cent. less than that required for the two-machine steam plow. With such a plant, the Borsig company further states, 2,500 hectares, or about 7,200 acres, can be plowed over at a depth of 14 inches, or an area twice as large as that which could be worked by the two-machine steam plow.

The electric plow works by means of two wire cables, which run in a parallel direction over the field, about three feet from each other. At one end an anchor carriage is used, which is so constructed that the carriage body itself is never influenced by the working plow, as the anchoring device is fixed to a kind of portable crane attached to the frame of the carriage. Thus the carriage frame itself can never get out of its original direction. As soon as the plow returns to the motor the anchor is lifted out of the soil by means of the motion of the idle plow cable, and this exactly for the distance which is required for the anchor setting in again.

In most cases, where the electric plow is used at present, the current is derived from a central station, from which it is transmitted to the field by means of overhead wires. From this overhead wire a flexible, isolated cable is, at a given point, connected to the motor car. The latter is placed on one end of the field to be plowed, and the anchor carriage at the opposite end of the field. The plow then travels between the motor car and the anchor carriage. As soon as one furrow is completed, motor and anchor cars advance exactly one furrow's space, when the work starts again.

The Borsig company asserts that the anchor carriages with disk wheels leave very much to be desired as to their practical use. The Borsigs therefore adopted for their system a multiple strong earth anchor, which, by the tractive power of the plow cable, fastens itself in the earth by self-action. A short chain connects the anchor with a rope pulley, the latter serving as a guiding device for the plow. Two horses are required for the transportation of the anchor carriage from field to field.

With regard to the use of the electric plows in sugar-mill estates, the company states that a special advantage lies in the fact that already existing stationary steam powers can be used for the generation of electricity, and that at the same time a number of individual plants may be supplied from such a central station. This is of the greatest importance, as in sugar factories the whole machinery lies idle during nine months of the year.

LAYING CABLES IN ARCTIC WATERS.

IN the accounts printed at the time regarding the difficulties of laying the first Alaskan cable last summer, and the accident to the "Orizaba," there were many errors, and a good deal of misunderstanding has occurred in regard to the work. George F. Porter in The Electrical Review, in clearing up the situation, says that the order which was given by the United States government contemplated the making, laying, and equipping of 187 miles of cable divided into two sections, one of which, 55 miles long, connected Unalaklik with St. Michael, while the other, 132 miles long, crossed Norton Sound to Safety Harbor at Cape Nome. For the purpose of laying the cable the steamer "Orizaba" was chartered, and her hold was made ready for the 187 miles of cable which was taken on board at San Francisco.

The steamship sailed from San Francisco and Nome City was reached in twelve days. Gen. A. W. Greely was taken aboard, and then the vessel went over to St. Michael to lay the cable from that point to Cape Nome. The day was fair and calm, and the cable-layers decided to waste no time, as the weather in that latitude is most uncertain. The shore end was towed ashore and connected with the cable hut, taking one hour and twenty minutes. Then the "Orizaba" was started on her way to Cape Nome at a rate of four and a half knots. Everything was moving smoothly until

the vessel was almost out of sight of land, when she ran on a reef. It was afterward discovered that the reef was charted and marked to give but 13 feet of water when the vessel was drawing 13½ feet. The ship rested easily, but was badly damaged, and it was necessary to at once take steps to save the cable and lay it if possible without delay.

A lighter was secured and a small ocean-going paddle-wheel steamboat to tow it, and the cable was pulled out of the steamship's hold and coiled on the deck of the lighter, the weather still holding good. The lighter was rigged up with a small jockey block on the end of a beam from its short mast, and through this the cable was passed. The combination of paddle-wheel steamer and lighter steered irregularly, and it was as well that there was plenty of cable, as it is now on the bottom of Norton Sound in a sinuous line, far different from the straight course that would have been taken had not the "Orizaba" perished on the reef. However, it was laid, and is now in good working order. The trip home to Seattle was made in a tramp steamer in which the company had many privations, as the vessel was short of supplies, and had to stop another vessel in midocean to get food and water.

The method of constructing the land-telegraph line from Unalaklik up the valley of the Yukon River through the various mining camps is novel. There is no timber in the country through which it passes, hence iron poles are used, and it is expected that this winter's snows, furnishing as they do good sleighing facilities, will permit the completion of the line. While the surface of the country is largely covered with the tundra or spongy moss, it is only necessary to dig a little way to find the eternal ice, and a pole is soon set and firmly held in position by pouring a little water into the hole around it, which freezes and will remain frozen forever unless disturbed in some way.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

German vs. American Exports and Industries.—I submit two interesting articles which appeared lately in the Leipziger Tageblatt, the most prominent newspaper in this city, says Vice-Consul Frederick Nachod, of Leipzig. The first gives a German view of the exports from North Germany to the United States during the third quarter of 1900, and indicates that the Germans are well satisfied with the present export trade to the United States and with the prospects for the future. In the second article, American manufactures and exports are discussed. The writer praises very highly the American manufacturer, his methods and his relations with the American workman. He compares them with the German manufacturer and workman, and, although he does not anticipate any danger from American competition at the present day, he nevertheless warns the Germans to be on the qui vive, and recommends that they imitate the Americans not only in their activity, but also in methods of manufacturing. He gives some good hints in regard to consular service, discusses the proposed imperial bureau of commerce, etc.

I may add that I find, through my commercial observations, that, although the import of American articles of manufacture into Germany is regarded with fear by some of the Germans, a larger part of the people rather welcome these importations, on account of their good quality at relatively low prices, and also because the keen competition acts as an incentive to Germans to bring their products to the highest possible point of perfection.

NORTH GERMANY'S EXPORT TO THE UNITED STATES.—During the third quarter of 1900 trade was brisk in Germany, as well as in the United States, and, although in certain branches of industry—namely, iron and cotton—there was a certain stagnation, this passed off without any perceptible influence on the other branches of trade. The Americans have had a splendid harvest with good prices, and the export of manufactured articles reached a figure never before attained; in short, they have made money and were consequently enabled to buy foreign goods in large quantities. Our export trade with the United States was quite satisfactory, showing an increase of 12.8 per cent. Should the last quarter of this year show as good results as the third quarter, the commercial interests will begin the new century on a very friendly footing. It is certainly time that we should arrive at a satisfactory standing, as we have lived through some very bad times toward the end of the nineteenth century.

The differences between the consular districts are quite conspicuous, some of them showing a heavy falling off (for instance, Berlin, 23 per cent.) and others an immense increase (Stettin, 163 per cent.). This is accounted for in that the trade with America is by no means even and steady, but changes according to fashion and times. The decrease in Berlin's exports is accounted for in that the American leather trust has effected an extraordinary large import of European hides into the United States within the last few years. In regard to the increase of exports, Magdeburg exported, among many minor articles, two principal products—Stassfurt potassic salts and sugar. The potassic salts are divided into kainit, kieserite, sylvinit, chlorite of magnesium, muriate of potash and fertilizing salts. These are indispensable for some manufactures and especially for the American farmer.

The second article—sugar—is our child of sorrow, because it is subjected to all sorts of chicanery and abuse and a heavy duty. For this reason it is sold in the United States only when none is to be had from other countries. We disposed of $357,000 worth during the third quarter of 1900, against $11,000 worth for the same period of 1899. Thus potassic salts and sugar have effected the great increase in exports.

With exports amounting to $13,000,000 for the third quarter of 1900, North Germany may well be satisfied; but still we must remember that during the first quarter of 1900 the exports amounted to $18,106,925, showing a considerable difference in favor of the first quarter. Should the last quarter make as good a showing we can consider the first year of the new century as one of our best.

EXPORT AND INDUSTRY.—The United States Government has published a statistical work in regard to the value of the industrial production of the principal countries. The reasons given for the pre-eminence of the North American production deserve our attention more than the figures which they accompany, as the figures can only be based upon estimates. However, these are by no means uninteresting. They are as follows: Value of industrial production of the United States, $7,000,000,000; Great Britain, $4,100,000,000, and Germany, $2,915,000,000 (certainly too low).

In accepting this view of the relative standing of the United States, Great Britain and our own country, we must not lose sight of the fact that the North American Union is only at the beginning of its industrial development, while Germany's industry is at a stage where it can be seen that it is nearing the utmost bounds of development set by existing natural conditions.

In regard to the intelligence of the American workmen in general compared with our own (American manufacturers recruit their workmen from Germany to a great extent), the former will hardly have an advantage. However, we must unreservedly admit that in the machinery employed in modern manufacture, we are considerably behind the Americans. The great amount of natural power at the disposal of the American manufacturers—the "white fuel," as the great water falls are called—has, together with high wages, encouraged the invention and employment of the most ingenious machinery, even in manufacturing articles that the average German still believes can be produced only by hand labor. In this field, we still have much to retrieve if we do not wish to be at a disadvantage in industrial production.

The Americans have the further advantage of possessing incalculable quantities of coal and ore. We may say that, at the present day as well as in the future, they are assured of the never-failing supply of fuel which is as indispensable for them as for their competitors, and therefore will not be compelled to import it from foreign parts, which would naturally add to its cost. We have just had, in the recent coal famine, an illustration of the serious effects a dearth of fuel would have on our industries. We should not delay, therefore, to make preparations to render the repetition of such a calamity impossible, or at least of no great consequence. We must endeavor to make ourselves as independent of power produced by fuel as possible, and, following the example of the Americans, endeavor more than we have in the past to employ the natural power which is also at hand in our country for industrial purposes. The beginning has already been made within the last few years by commencing the construction of large dams, etc., which, when finished, will extend across many valleys in different parts of our country. But even these measures will not be sufficient to meet our future requirements when our fuel and raw materials are exhausted or when the consumption of indigenous materials becomes too expensive to be practical. At such a period, colonies with rich ore and coal deposits would be of inestimable value to us. Viewed from this standpoint, the acquisition of Kyao-chau, which is the richest in ore and coal of any section of territory in the world, will be considered as a most fortunate action on the part of our Imperial Government.

Of the utmost importance to our commerce and industry is the cheapening of our transportation facilities by improving and extending our water ways. The Prussian Government deserves great credit for the perception it has shown in regard to this necessity. It is to be hoped that they will succeed in passing the canal bill through the legislature. Our manufacturers must never lose sight of the fact that cheapness is of the greatest importance in disposing of their productions. The cheaper we are able to produce goods the easier it will be for us to retain our position in the world's markets and to open up new ones. Therefore, our manufacturers should, before all things, bend their efforts to reducing the cost of production. For the disposal of our products we can let our exporters provide, the latter having given excellent proof of their capabilities.

Indispensable also is the closing of more favorable commercial treaties with foreign governments. Space does not allow us to discuss at length the general views (which, by the way, are by no means unanimous) as to the policy which should serve as a basis for such treaties. We confine ourselves, therefore, to urging the necessity of regulating, by a paragraph to be inserted in all commercial treaties, the treatment of commercial travelers and their samples by customs and tax officials, so that treaty concessions may not be counteracted in effect by obstacles in the way of a necessary branch of the export trade. The law instituted within the past year by the Russian Government for collecting a tax from foreign commercial travelers is an instance of the necessity of such a provision.

It is also very desirable that our consular officers should consider every expedient for furthering our export trade; also, that in appointing consuls more weight should be laid on commercial experience and knowledge of political economy than has been done heretofore; also, on the appointing of professional consuls, and avoidance of continually transferring them from one charge to another, which renders it impossible for them to become acquainted with the peculiar conditions existing in their districts. The appointment of commercial agents or attaches is also to be recommended. Complaints were formerly very frequent on account of the delay in publishing the often very valuable information contained in the consular reports. Since, however, the Department of the Interior has instituted a weekly pamphlet entitled "Nachrichten fur Handel und Industrie" (News for Commerce and Industry), which is sent free of charge to interested persons upon application and is given to the press, these complaints have ceased. This publication contains information regarding industry, agriculture and all tariff and trade conditions, especially of foreign countries. The data is thus communicated to the people to whom it is of vital importance very shortly after it is received.

The creating of the so-called consular attorneys by the Government of Austria-Hungary is an institution worthy of imitation. A written agreement is made by these attorneys with the respective consuls, in which the former bind themselves punctually, conscientiously and for reasonable fees to look after the interests of Austro-Hungarian subjects. Business men of experience know what it is to be compelled to bring action against unscrupulous debtors, who venture to swindle foreign creditors only when they calculate that the creditors fear to fall into the hands of unreliable attorneys, who will strive to make the costs of a lawsuit as high as possible.

The greatest demand made on State assistance, in the so-called interests of the export trade, is contained in the project for establishing an imperial bureau of commercial information. Many large commercial corporations have already refused to support this project, one of the reasons given being that there is danger of industrial firms conceiving the idea that all help should come from the Government, while the success heretofore attained by our commerce and industry has been solely the result of their own efforts. Undoubtedly, the aim of the manufacturers in urging the establishment of an imperial information bureau is to do away with the export commission houses, so as to avoid dividing profits with them. At present, most of the exports of manufactured articles are made through these firms. It is evident that the manufacturers have a mistaken idea that the export branch of trade is of no great importance; that it requires no especial knowledge, experience or foreign connections; and that an able and successful manufacturer should also be a successful exporter. The calling of an exporter demands such diverse knowledge and experience that it involves many years of hard work to acquire the same. We call attention, as a proof of the abilities of our exporters and their agents, to the high point to which they have brought our foreign trade; also to the envy betrayed in commercial reports of foreign consular officials. It must fill our manufacturers with pride for present success attained and with confidence for the future to work hand in hand with merchants of whom the Foreign Office in London recently spoke, in regard to Korea's commerce and industry, as follows:

"English merchants could open up many markets in the East if they would learn the language of the country; but this is apparently the very last idea that occurs to them. The Germans, who are very much more practical than we, realized this very quickly, and now it is an exception to find a German commercial house which has not at least one man who can transact business with the natives in their own language. In Korea there is a German firm and an English firm; it is superfluous to say that the German firm has a German sales agent who speaks the Korean language, and that the English house has no Englishman who knows anything of the language."

But, aside from knowledge and experience in the export trade, it must not be forgotten that it is the good reputation of the German commercial houses and of their managers and their many years' personal and commercial relations with their foreign customers which have done so much toward obtaining orders; and that if our manufacturers dispensed with their agency they would have to begin from the beginning, the same as any other stranger, to win their place in the markets of the world. It is not necessary to say that this would take some time; therefore, the exporters for exportation and the manufacturers for manufacturing. The latter have before them so many difficult problems to solve, which have already been mentioned in the first part of this article, upon the solution of which depends their future success in international competition, that they can hardly think of assuming the cares and responsibilities of the exporters without neglecting the vital interests within their own branch. The watchword of both branches must be in the future, as in the past, "March separately, attack together, for the glory of our industry and our commerce."

Market for American Shoes in Tunis and Algiers.—Consul-General Lay, of Barcelona, under date of November 17, 1900, sends an extract from a Barcelona trade journal of recent date, as follows:

"The agents of a firm in Palma (Majorca) visited Tunis and Algiers a few days ago, offering white-cloth shoes with leather soles and heels. These goods have a very ready sale in that market, and with slight effort large quantities of shoes could be placed."

Mr. Lay adds that he has suggested to our consuls at Tunis and Algiers the advisability of inquiring into this matter, in order to bring it to the notice of any American firms desirous of competing in that market.

German-African Steamship Line.—Consul Hughes, of Coburg, under date of November 30, 1900, calls attention to the establishment of a new East African steamship line, with a large Imperial Government subsidy, to run from Hamburg to the Cape of Good Hope, via Las Palmas or Teneriffe and back via the Suez Canal, taking in the East African coast towns.

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No. 934. January 14.—*A German View of American Prosperity—*Proposed Electric Railway for Leicester.

No. 935. January 15.—Electrical Works in Amsterdam—Cost of Electrical Works in Europe.

No. 936. January 16.—Foreign Trade-Marks in Germany—The Growth of German Cities—American Cotton Plants for German Togoland—*Chinese Silk and Tea Trade.

No. 937. January 17.—The Carrara Marble Industry—Device for Preventing Shipwrecks.

No. 938. January 18.—*New Spanish Railway—Freight Rebates in England—Silk Production of the World—Calcium Carbide in Germany—Double-Scale Tariff in Germany.

No. 939. January 19.—Wages and Prices in Siam—The Nova Scotia Coal Strike—Office Furniture in Germany—Ice and Refrigerators in Brazil—Customs Dues at Vladivostock—Colombian Ports Closed to Commerce.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

Waterproof Putty.—Cement for petroleum lamps, panes in aquariums, knife handles that have become loose, as well as for any other waterproof closure, is produced from litharge and glycerine. The former must be as finely powdered as possible and the glycerine very condensed, of a sirupy consistency and limpid. Mix the two ingredients into a semi-liquid paste, coat the places or pour the tough mass into the respective cavity and press the part to be cemented on, such as a knife blade or petroleum fount, into it. The surplus oozing out must be removed at once and the place cleaned at once as the putty hardens very rapidly. For the same reason it is advisable to preserve the ingredients separately and to mix no more of the material than is required at the time. No subsequent loosening or giving need be feared; besides this cement has the advantage of great simplicitly over other variously composed mixtures.—Das Deutsche Handwerk.

To Unoil Leather Belts.—Lay the belts in a basket with sawdust, of wood free from resin, and place the basket in a warm room. The sawdust will draw out the oil completely. For very oily belts the process may be repeated. The belt may also be laid for four to five minutes in hot water of 83 deg. C., rubbing off the oil afterward. The water is poured off previously because the oil floating on top will cling to the leather again. This must not be done more than twice, so tnat the leather does not become spongy. A third process consists in placing the belt in a room at a temperature of 40 deg. C. and to rub it dry, after exudation of the oil, with sawdust. 2. Roll the belt into a disk and lay it, tied up, in benzine in a covered tin vessel. On the day following stretch it out and expose it to the wind for about one hour. Even thick leather may thus be freed from oil, except a very slight quantity, and dried again. The benzine, filled into a well-closed jug, may be employed many times for the same purpose, and finally used for fuel mixed with sawdust.—Die Werkstatt.

Toilet Powders.—

PEARL POWDER.

Powdered chalk	450	grammes.
Bismuth oxide	28	"
Zinc oxide (powdered)	28	"

Mix and pass through a sieve.

VIOLET POWDER.

Starch	5400	grammes.
Orris root	900	"
Essential lime oil	14	"
Essential bergamot oil	14	"
Extract of civet	7	"
Clove oil	7	"

Well mix the powders, as well as the perfumes, whereupon they are added to the powders and twice passed through a sieve.

FACE POWDER.

Bismuth oxide	112	grammes.
Starch	450	"
Attar of roses	10	drops.

Mix well and sift.

ROSE FACE POWDER.

Starch	3150	grammes.
Rose oil	2	"
Essential bergamot oil	20	drops.
Attar of roses	10	"
Rose geranium oil	60	"

Mix well and sift.—Journal de Parfumerie et Savonnerie Françaises.

Indelible Ink for Marking Linen, etc.—Mix equal parts of coal tar and benzine and add to the mixture enough lampblack to render it intensely black. The composition must be well stirred, so that the mass forms a uniform paste. Apply some of this paste on the back of a moderately thick rag, the upper end of which is nailed on a board, the rag is then laid upon the board in such a manner that the face is on top. The face is then used as an ink-pad and the impressions made with it are almost indelible. Each impression must, however, be given sufficient time to dry, so that it does not blur.

Good writing ink for wash is produced as follows, mixing the substances well together:

	Grammes.
Copper sulphate	15
Ammonia	50
Silver nitrate	10
Tartar	10
Dextrin	10
Sugar	5
Sodium carbonate	10
Lampblack	1
Distilled water	80

The composition thus produced can be used for writing like any other ink and withstands the ordinary washing and bleaching processes for some time.

An ink, which remains visible for years, is prepared in the following manner:

First mix:

	Grammes.
Crystallized cupric chloride	8.5
Sodium chlorate	10.6
Sal ammoniac	5.3
Distilled water	60

Preserve this mixture in a special flask.

Next mix:

	Grammes.
Glycerine	40
Gum water (consisting of gum arabic 1 part and water 2 parts)	80
Muriatic aniline	80
Distilled water	120

Preserve this mixture also in a special bottle. For use, mix 1 gramme of the first liquid with 4 grammes of the second liquid, thus obtaining an almost indestructible linen-marking ink. Either of these mixtures may be kept for itself a long time, but the finished ink decomposes in about 12 hours, for which reason the mingling is only done just before use.—Wäschekuche und Plättstube.

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